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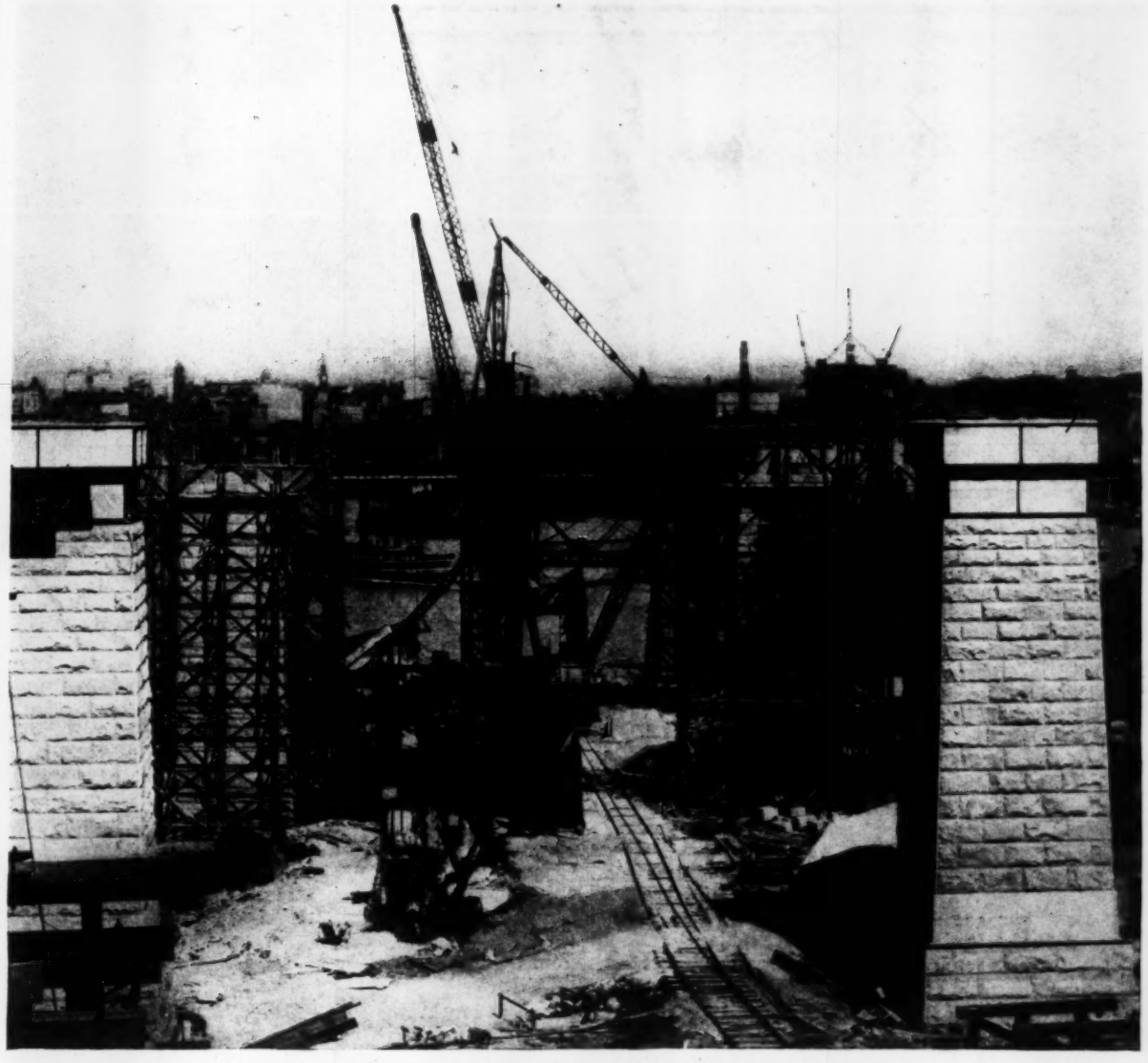

Approach Viaduct Piers; 1650-Ft. Arch Bridge
Sydney, Australia

Early Stages of Sydney Harbor Bridge Construction

Relation of Water Consumption to Sewage Discharge at Denver

Equipment Costs for Gravel Road Maintenance

Memorial Tower Built to Last Through Ages

Quicksand Tunnel Timbered From Needle Beam

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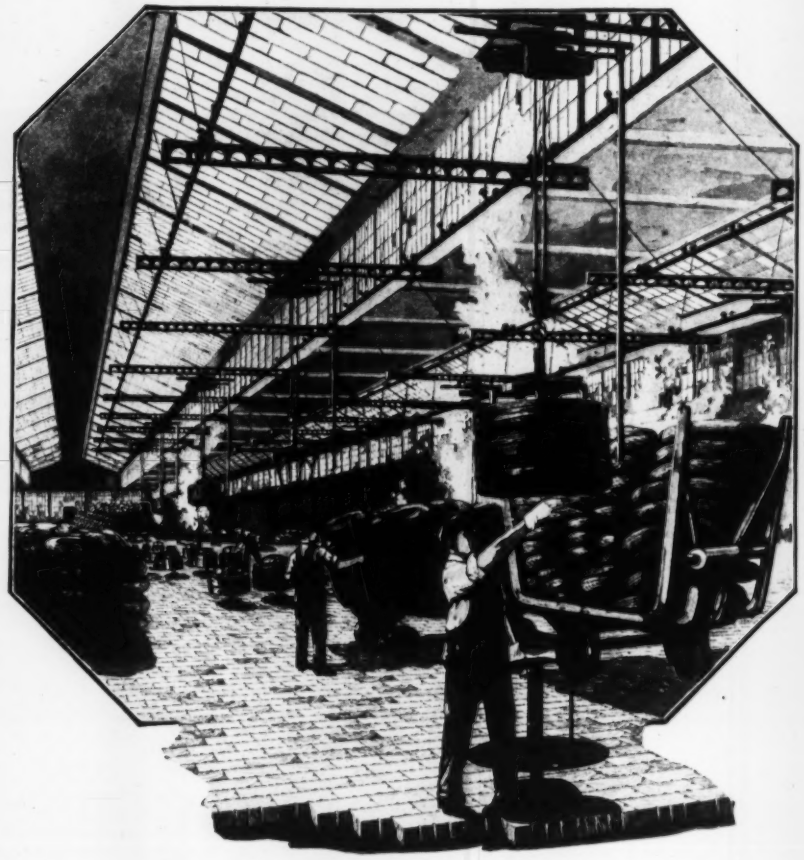

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DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

WILLARD CHEVALIER
General Manager
F. E. SCHMITT
Managing Editor

Volume 100 NEW YORK, APRIL 5, 1928 Number 14

Business as Usual

WITHIN the week the country has witnessed as frothy an ebullition of speculative enthusiasm as normal times ever see. Our stock exchanges became as hysterical as were the realtors' rows of the Florida land boom two and a half years ago. The frenzy of the security markets might have seemed the precursor of a collapse of confidence, credit and business stability. In olden times it would have foreshadowed just this, but not so today. There is not a breath of disturbance in any of the activities of production or commerce. No possible connection can be traced between business and today's stock exchange. The antics of the ticker and its obsessed votaries are little more than phases of a huge policy game in which an epidemic gambling fever is manifesting itself. This fever means nothing whatever for either manufacture or construction. Current statistical records of solid finance, of contracts and of commodity markets show that these are running a healthy and active course. Whatever tendency the present mad speculation may have toward producing a large-scale debasement of personal principle, and whatever responsibility on this account may rest on the controlling authorities of finance, the business structure of the country is not involved. Business is going on as usual.

The Senate Has Voted

THAT supremely deliberative body the United States Senate departed from its traditional attitude in a surprising way last Wednesday, in voting on Mississippi River control. Even before full discussion had been had, the much-amended Jones bill was put to vote, and hurriedly the Senate approved it, with almost unanimous voice. It seemed indeed as if the Senators present were anxious to get the thorny question out of the way. They had previously transformed the original bill into a nondescript compromise between the diverging views of the executive department and the Valley states. They retained the technical recommendations of the Jadwin plan as basis for the work, and fitted their expenditure figures to the very low cost-estimate of that plan; but at the same time they undertook to commit the nation at large to full payment of all costs—not only for works but also for land and incidental damages of every kind, as the Valley residents have demanded. In one clause they directed that the Jadwin plan be carried out; in another they forbade anything but levee and revetment work to be done—until some indefinite time in the future when the problem shall have been restudied and a new Congress shall have acted on it. They initiated an enterprise of greater size and difficulty than the Panama Canal, yet destroyed the independence and authority of the engineering body on which the work must depend and placed that body under bureaucratic control. Thus the bill as passed by the Senate brings together hopelessly conflicting conditions. It pretends to ordain that the floods of the Mississippi shall be fully controlled and all land owners or residents of the flood lands be saved harmless, at an expenditure of $325,000,000. This is well known to be impossible. The country is likely to face a total payment of a billion or more if the House accepts the Senate bill. But the House has yet to vote. And finally, there will be future Congresses which may correct the rash actions of the present one. In another column the needs of the present situation are briefly reviewed. The course taken by the Senate is far from meeting these needs.

Drought or Flood

EXTENSIVE fires that swept the Everglades in the latter half of March bring into view with unusual clearness the sharp conflict between opposing requirements on control of Lake Okeechobee, the drainage basin of southern Florida. When the flood runoff of the Kissimmee River is impounded at a high level, there is the risk of death-bringing overflow of a storm tide, as in the Moorehaven disaster at the time of the great hurricane of September, 1926. After that disaster it was decided that the lake must be held to lower levels to assure safety from such flooding. This done, however, the stored waters are no longer able to keep the vast muck-marshes of the Glades from drying out to a point where crops on reclaimed lands wither and great fire losses threaten. So the difficult problem of controlling the waters of that extensive region and bringing nearer the useful development of the millions of acres under the rim of the lake has evidently not yet reached a final solution. The fires of this spring suggest that high-level storage is a practical necessity and that the flood hazard may need to be dealt with by dike protection of the shores.

Maintenance Equipment

PROGRESS in the machine maintenance of roads has reached the stage where maintenance engineers have begun the sifting process in renewing equipment. At first, when a few years ago maintenance became statewide and continuous and not local and sporadic, equipment was picked up as it could be. Selection was a matter of personal choice and largely haphazard. Virtually all equipment was team-operated. Then the distribution of surplus war trucks and tractors introduced the new element of power operation. Still, however, equipment selection remained haphazard. Maintenance engineers had to take the free trucks as they could get them, and as delivered they were of all sorts and conditions. The engineer's problem was to use as best he could the tools that were at his hand and postpone any exercise of refinement of selection. The war truck and tractor, however, accomplished the great task of converting highway maintenance from horse power to motor power and thereby turning attention to sizes and speeds and costs. The process of development is excellently exemplified by the changing

practices in Gogebic County, Michigan, as described in this issue. The experience which this forward Michigan county has gone through is a sample of the experiences of county and state maintenance departments generally. The significant fact in all cases is that the stage is being reached when the donated war trucks have done their day's work and new power equipment has to be bought, and sifting and selection is in progress among the machines that crowd the maintenance field. The same process went on a little earlier in road construction equipment, and, as was the case there, we are likely to witness in maintenance equipment a simplification in kinds and sizes.

Water Use and Sewage Flow

GUESSWORK is the unreliable foundation on which most cities build up their theories—if they attempt that much—of the volume of sewage that they pass on to stream, lake or ocean. Exceptions are afforded by some cities, chiefly those that pump or treat their sewage. Guess or estimate, the basis assumed is the volume of water consumed and wasted for domestic, business, industrial and other purposes. The most careful, extended and large-scale attempt to correlate the two that we remember is afforded by the Denver measurements reported at length elsewhere in this issue. That they have been prompted by a lawsuit, brought by downstream users of water for irrigation, only adds to their interest. The close agreement between the volume of water diverted to the city for municipal supply and returned to the river as sewage is notable. That little ground water gets into the sewers is not so surprising, climate and soil conditions taken into account, as that the studies should indicate so small a leakage from the water mains. While few engineers would go so far as to wish that other cities would be forced by lawsuits to make similar studies, all interested in sewer and sewage-works design will welcome the data arising from the Denver controversy. More such, however brought into being, are to be desired.

Machine-Finished Asphalt

A DEFINITE advance in bituminous pavement construction methods is registered by the Oklahoma road work described in last week's issue. With slight changes, a screed-type machine for finishing concrete roads was used to place asphaltic concrete, with gain in speed, output, cheapness, evenness of placement and trueness of surface. The facts given are notable, and they do not stand alone. A similar experience is recorded in California on two paving operations carried on in 1927. On one a standard finishing machine was employed. A brief account of the work appeared in *Engineering News-Record* of Oct. 13, 1927, p. 602. The second experiment was on a larger scale. A standard finisher was incorporated with a spreading screed and raking device on a common carriage. The composite machine has the indication of being cumbersome, but the reports at hand show that it did good work. In particular it is reported that it gave a surface so true that the roughometer showed only ten units of roughness as compared with eighteen units on hand-finished asphalt pavements and six to eight units on the most truly surfaced concrete pavements. Without entering further into methods and equipment, the conclusion seems certain that machine finishing has reached a stage of development which gives black-top roads a higher rank in precision of construction than they could ever have reached as long as hand placing and finishing were employed.

Needle-Beam Tunneling

REFINEMENTS in the use of needle-beam bracing have put this device into the same category of security as the shield, for quicksand tunnels of moderate diameter. Contractors in Cleveland, as described in this issue, and in Detroit, as described in the issue of Dec. 15, 1927, are holding soft ground, virtually a quicksand in places, with radial bracing from a needle beam to liner plates. In the Cleveland operation all the work is in compressed air, whereas at Detroit air is put on only on occasion. Details of the two procedures need not be repeated, but it may be remarked that observation of both discloses underground operations as open and clean as are often seen in tunnel construction. The needle beam offers the most simple and direct system of bracing possible for circular tunnels; and with the use of liner plates of steel or timber the closing of the walls can be made substantially as tight as with a shield. The mechanism and power service required are vastly less complex than are required for shield operation. Where skill and care are exercised, the security of the operation has not proved greatly less. The speed has been as great.

Flood-Control Legislation

PRECIPITATE legislation on a momentous question, as represented in the Senate's passage of the Jones flood-control bill, cannot invite either public or engineering approval. Its political background is obvious. Every Senator looking for votes in his coming campaign has assured himself the human-interest appeal of having done all that he could for the pleading flood-sufferers. Why bother with details of the bill or its amendments? The President can be counted on to veto the measure!

If the Senate's action gives warning that Congress is simply playing politics in the flood issue and is evading a direct answer to the problem of Mississippi flood control, constructive thinking on the subject becomes the personal obligation of the citizen. Let us therefore inquire what line of action gives real promise.

To begin, it must be recognized that no one at this time can say with assurance what is the best course. There are many strong convictions and many clashing opinions; but, as in other controversies, there would not be much difference of opinion were all of the facts known. But not all of the legal, financial or economic facts about the Mississippi are known—much less are the engineering facts known.

To review only a few of the unknowns, let us take up first a legal question. The doctrine of the servitude of land downstream to care for flood flow stands without question, of course. But when it is complicated by the man-made changes in the river by levees and revetments, in the terrain by drainage, in the cover by deforestation, and further complicated by reservoirs and irrigation, it is not surprising that the Mississippi River Commission interprets the doctrine one way and the Chief of Engineers another. The one feels that flowage rights must be paid for, whereas the other feels that at least the United States will not have to pay. Engineers should not have to depend on their own interpretations in such a matter.

Again, consider the economic question of whether certain areas should or should not be protected. Little information exists in usable form of the present actual use of the land and its value. Certain statistics have been compiled as to valuations and acreages of cleared land, but how much of it is in cultivation and where it is located is not known. In 31 levee districts that comprise practically the whole area needing protection, having a total acreage of 17,000,000 acres, of which 7,000,000 is cleared, the assessed valuation is $504,000,000. Against this there is a total indebtedness of $413,000,000, but only $36,000,000 of the total, or $2.13 per acre, is for levee bonds. Losses from the 1927 flood in these districts were $111,000,000, or $6.60 per acre. Whether, then, it is good economics to spend from one-third billion to a billion dollars to save property valued at half a billion is a pertinent question. Certainly some further economic balancing is needed against what this property will be worth with protection in ten to twenty years. When some estimate of future values is made, some reasonable figure as to apportionment of cost can be arrived at. Since the country as a whole must pay the bulk of the new costs, some appraisal is needed as to what the country as a whole is going to get and what its own relation is as to the added acres, surpluses and consequent competition with lowered prices. Doubtless it was the recognition of the lack of economic balancing that brought support to the proposal for an economic commission.

With more of these economic questions answered, the individual Congressman would be in a much better position to vote on Valley appropriations and know whether he was serving the best interests of the country.

Lack of information on physical features, on the other hand, has led to more controversy over engineering than over anything else aside from cost apportionment. The commission was forced to get out a plan in a hurry. Its plan was returned several times for correction and revision. Being closer to the project than anyone else, it realized more fully the lack of information on which to base judgment. Forced to abandon the levees-only policy because of the magnitude and synchronization of the 1927 flood and to consider auxiliaries in the form of spillways, diversions, levee setbacks and reservoirs, it found meager data with which to work. Hitherto these auxiliaries had been brushed aside with scant consideration. Even had they received careful study, the encroachments of civilization made the problem a new one. No topographic maps existed and no economic surveys were available on which to base cost estimates. The engineer was thus without his most vital yardstick of comparison. His educated guesses, assumptions and the actually known data became inextricably mixed up in his reports, all to the bewilderment of his clients. His hydraulic calculations looked extremely formidable and convincing until one learned of the woeful lack of information on which they are based.

Practically every auxiliary proposed needs so many more basic and fundamental data, followed by economic comparisons of alternates, that the engineering profession of the country simply cannot accept any comprehensive plan now which must be dependent on these auxiliaries.

Since there have been basic studies and a fixed policy borne of long years' experience on how to handle that part of the flow which practically every one has agreed will always be carried between the levees, what more natural and logical thing to do than go ahead with that program while studying the auxiliaries? There is little controversy over revetments, so Mr. De Berard reported three weeks ago. Two years' work is yet to be done on completion of the levees to the height of the existing project. Forty-five million dollars' worth of work awaits appropriation, either for the whole or in part by the United States. That much, together with money for revetments, all of which is to be paid (everyone agrees) by the government, should be appropriated at once so that the 1928 construction season will not be lost.

In a separate bill should be set up organization and sufficient appropriation for a thorough study of the comprehensive plan and auxiliary questions. But perhaps it is not worth while for the engineer to worry about organization. Political statesmen will prefer political forms of organization.

Old Lessons Repeated

OUTSTANDING among the lessons of the Fall River conflagration on Feb. 2 of this year, disclosed by a report of the National Board of Fire Underwriters, are the hazard of a large unused group of buildings close by the central business district of a city on the one hand, and on the other the value of an ample water supply with plenty of reserve pumping capacity. The hazard caused by the Pocasset Mills, in which the conflagration started, was greatly increased by the fact that they not only were idle but were being torn down, their sprinkler system partly removed and none of it in use. Even so, had their owner or the city gone to the slight expense of maintaining a fire watchman there might have been no conflagration, for apparently the fire had been burning 1½ hours before it was seen by anyone.

Lesser teachings of the conflagration confirm equally well known but too often unapplied first principles of fire prevention: The value of inside sprinkler and of window sprinklers and of solid walls as fire breaks; the undoing of otherwise "fireproof" construction by the use of a wooden roof; the value of uniform couplings for fire hose and hydrants when outside fire companies come to the aid of a city—partly offset at Fall River by the use of flush fire hydrants requiring portable chucks for their opening, different from the chucks brought from Providence and Boston. As has happened repeatedly elsewhere, burning cinders carried by the winds to wooden buildings drew some of the fire fighters away from the conflagration and weakened the efforts being made to control the fire. With higher and longer-sustained winds in these directions, thousands of wooden buildings might have been destroyed.

Altogether, the lessons of the Fall River conflagration are cumulative rather than new. They show once more that our American cities are liberal in providing water-supply and fire-fighting equipment and can depend on help from the fire departments of neighboring cities, but that cities and property owners alike are negligent in the use of well-known fire-prevention methods. A single watchman at the Pocasset Mills might have detected the fire at so early a stage that it could have been easily extinguished. His wages for the period since the mills were shut down would have been trifling compared with the total destruction of 38 buildings, with damages to 71 more and a total loss of more than $6,000,000, of which some $4,000,000 falls on the insurance companies and the remainder to be borne by the owners.

Early Stages of Construction on 1,650-Ft. Arch Bridge at Sydney, Australia

Steel Arch Span to Carry Railway and Street Traffic Across Harbor—Foundations and Construction of End Bearings—Travelers for Arch Erection

CONSTRUCTION of the great 1,650-ft. steel arch bridge across the harbor at Sydney, Australia, has progressed so that by the end of 1927 the four bearings for the arch ribs had been placed, work started on the arch erection and considerable work done on the approaches. The general design of this bridge is shown in Fig. 1. Figs. 2 and 3 show the placing of anchor bolts and base castings for the end bearing of one arch rib, and Fig. 5 shows this bearing completed and ready for the structural steel. On the deck carried by this arch span, with 170 ft. headroom for navigation, will be a 56-ft. roadway, two tracks for the electric rapid-transit railway described in *Engineering News-Record*, Aug. 25, 1927, p. 310, two tracks for electric street cars, and two sidewalks.

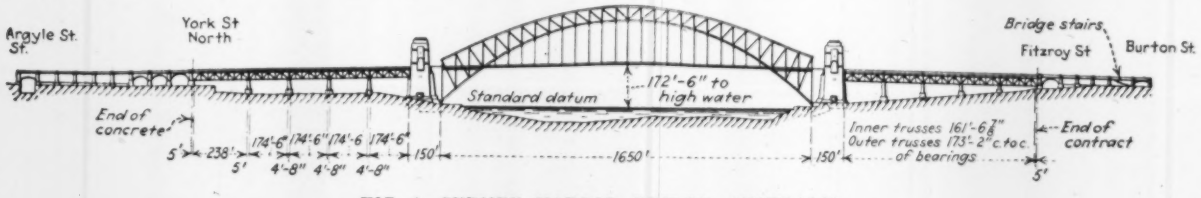


FIG. 1—SYDNEY HARBOR BRIDGE, AUSTRALIA
Arch span 1,650 ft. c. to c. of bearings.

Foundations—On each side of the channel there is solid sandstone rock, which has been explored by diamond drills to a depth of 60 ft. On the city side, a bed of shale occurred at foundation level and was removed down to the solid sandstone so that the foundation base is flat, as in Fig. 4. On the opposite side the foundation was stepped back to follow the bedding of the sandstone rock.

A curious arrangement of concrete for the main body of the abutment which takes the arch thrust is shown by Fig. 4, the concrete being poured in hexagonal blocks or steps tranverse to the axis of the bridge. Each block was left for seven days before any adjoining concrete was poured, so as to allow for shrinkage in setting. Near the surface a richer mix of mass concrete was placed, and on this again was a still richer mix directly under the bearing. The composition and strength of concrete are given in the accompanying table. In Fig. 2, the 24 anchor bolts, 4½ in. in diameter, are shown adjusted to line and level in the steel frame before the rear portion of mass concrete was poured. This frame was removed when the heels of the bolts were securely held by the concrete. Each skewback is 40 ft. wide and 90 ft. long, founded on solid rock at least 30 ft. below the surface.

End Bearings—The steel bearing on which each end shoe is seated consists of six 26-ton steel castings seated on the 45 deg. masonry skewback and carrying an A-shaped shoe or pedestal built up of two forged steel webs bolted together, with cast-steel diaphragms between them. These webs, 9½ in. thick, weigh 33 tons each and are inclined together at an angle of 54 deg. At the apex of this pedestal is a forged steel shoe for the 14½-in. end bearing pin, which pin is 13 ft. 8 in. long. The first structural steel member of the arch rib is riveted to a similar shoe resting on the end pin.

The placing of one of the base castings is shown in Fig. 3. Each of the six castings is 21x4 ft. and 3½ ft.

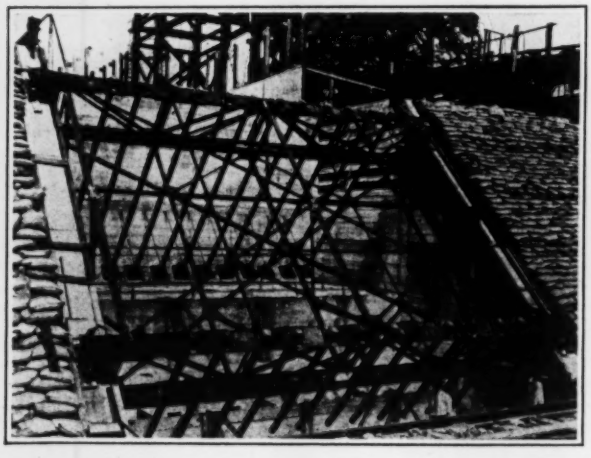


FIG. 2—ANCHORAGE FOR ARCH SHOE
Steel frame or templet was removed when bolts were firmly bedded in concrete. Note suspension of ends of rear bolts.

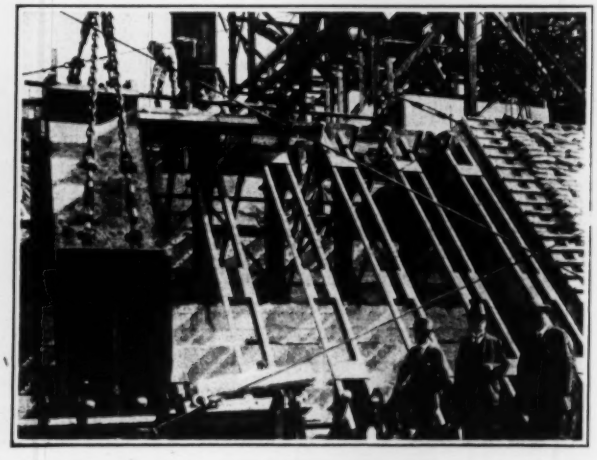


FIG. 3—PLACING THE FIRST BASE CASTING
Six castings forming the base were assembled on the inclined steel frames, which were then removed.

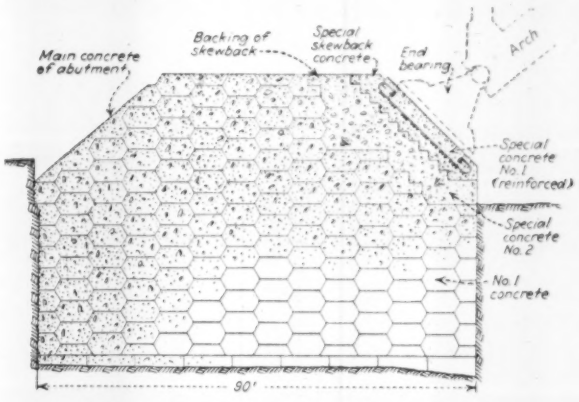


FIG. 4—ABUTMENT FOR ARCH BEARING
Concrete poured in separate stringers or blocks to allow for shrinkage.

high. They have interlocking dovetailed lugs, so that when bolted together they form practically one piece covering an area 21x24 ft. At each end of each casting are holes for two 4½-in. anchor bolts.

A second steel frame was erected upon which the base castings were assembled (see Fig. 3), after which the base was supported by jacks at the corners and the frame was removed to allow of placing the special concrete which forms the surface of the skewback. This concrete was poured continuously; starting at 6 a.m., the 170 cu.yd. was placed and thoroughly tamped in fourteen hours.

From the bearing pin the arch thrust is transmitted through the pedestal, Fig. 5, to the cast-steel base, 504 sq.ft. in area, which rests on the inclined face of the skewback. The height from this base to center of pin is 14 ft. and the total weight of bearing, inclusive of end pin, is about 296 tons. On the face of the reinforced-concrete skewback the pressure is about 800 lb. per sq.in., which reduces to about 200 lb. on the sandstone rock.

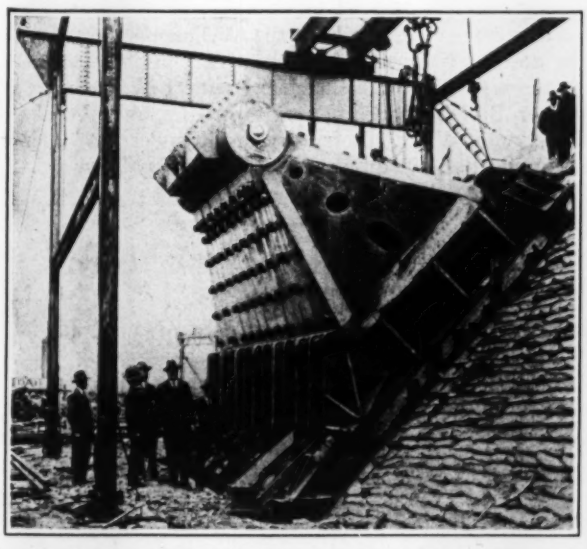


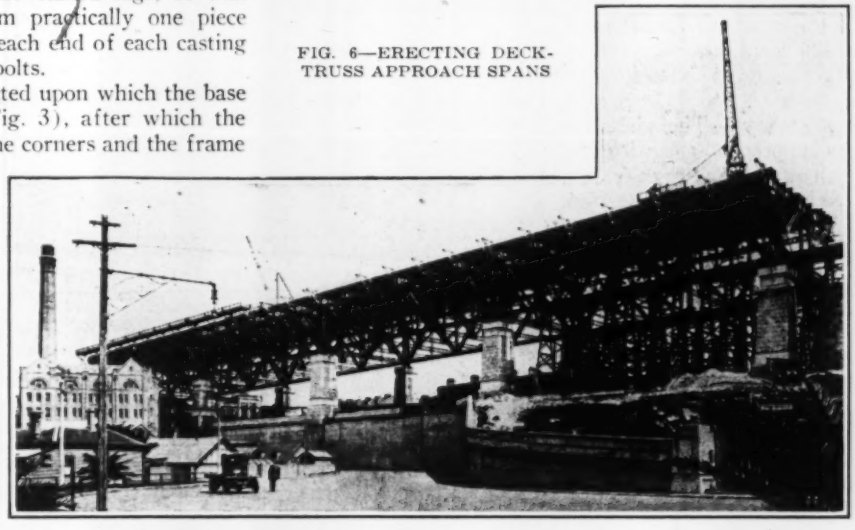
FIG. 5—COMPLETED END BEARING FOR ARCH
Hydraulic jacks support corners of base while placing concrete for surface of skewback. The 14½-in. shoe pin is 13 ft. 8 in. long.

At each end of the arch are five deck-truss approach spans, erected on falsework, as shown in Fig. 6. The total length of steel structure over main and approach spans is 3,770 ft.

Erection of Arch—For erecting the main span by cantilevering from each end, two special travelers were built, riding on the top chords of the arch ribs, which are spaced 98½ ft. c. to c. The construction of one of these travelers is shown in Fig. 7.

A transverse frame built up of trusses nearly 148 ft. long is mounted on trucks the flat-tired wheels of which ride on the cover plates of the chords. This frame carries a crane that has a lateral travel of 118½ ft., so as to serve both ribs. The crane boom revolves on shoe pins and its luffing movement (in the vertical plane) is effected by power-driven nuts on screws 9 in. in diameter. The main hoist can handle 65 tons at a maximum reach of 60 ft. 9 in. or 122 tons at 40 ft.; its minimum reach is 13½ ft. On the lower chord of the crane boom travels the trolley of an auxiliary 20-ton hoist by which the members can be tilted to the proper angle for placing them in position. Traversing the crane is effected through rack-and-pinion gear. End thrust on the traversing carriage, due to the incline of the arch, is taken by rollers riding against a heavy girder on the rear of the main carriage or underframe of the traveler.

FIG. 6—ERECTING DECK-TRUSS APPROACH SPANS



For handling the lighter material, riveting equipment and working platforms, the rear of the traversing or crane carriage is equipped with two 2½-ton cranes, so adjusted that their masts are vertical. These cranes, shown by dotted lines in Fig. 7, can swing through an entire circle and thus deposit material forward on the main frame of the traveler, where it can be picked up by a 5-ton crane on the forward side of the traveler.

With the main hoist, the maximum capacity is 122 tons at 12½ ft. per minute, or 65 tons at 25 ft., with two 120-hp. motors. The auxiliary hoist, with a 50-hp. motor, can handle 20 tons at 25 ft. and can travel along the boom with this load. The crane with 122 tons load can be traversed at 30 ft. per minute by a 50-hp. motor and can be luffed from maximum to minimum reach in five minutes by two similar motors. Forward movement of the traveler up the arch incline at 1 ft. per minute is

effected by a 50-hp. motor. The auxiliary crane with 5-ton load can hoist at 60 ft. per minute, swing through a complete revolution in one minute and traverse at 50 ft. per minute.

A double-drum cable haulage system advances the traveler as the work progresses, and is operated by a single 50-hp. motor. The cables are led to pulleys temporarily attached to the tops of the chords. Should one end advance a little more than the other, a limit switch cuts out the motor, the drums being then operated independently to bring the traveler frame square with the bridge before proceeding farther. To insure safe operation on the steep incline of the arch, two link-and-pin safety chains, on motor-driven sprocket wheels in the frame, are anchored ahead of the traveler. A motor automatically keeps the chains tight, but they are independent of the haulage system.

Masonry — The piers for the approach spans, faced with quarry-face granite, Fig. 6, are 14x17 ft. at the top, with a batter of 1 in 30. Similar facing is used for the end towers and pylons of the arch span, which rise to a height of 285 ft. above the water and by their weight serve to steepen the resultant of arch thrust and thus reduce the size required for the skewback foundations. From the ground surface to the level of bridge deck the reinforced-concrete towers, 223x162 ft., are hollow but are stiffened by interior walls. Above the deck level the pylons are of similar construction, and each is pierced by an arched opening to carry a sidewalk and a railway track.

Both quarry blocks and crushed granite for the concrete were brought in by water. Crushed stone was unloaded by grab buckets and dumped into a hopper, which fed a belt conveyor delivering it to the storage pile. The masonry work of the approaches is being done by day labor.

Engineers and Builders—The contract for fabricating and erecting the steelwork of the arch and the approach spans was let in March, 1924, to Dorman, Long & Company, Middlesborough, England, at £4,250,000, or about $18,300,000. All structural steel was manufactured in Australia, but the steel castings and pins for the end bearings were made in England. A special testing machine to test the members and details was described in *Engineering News-Record* of Sept. 16, 1926, p. 468. The erecting cranes were built by the Wellman-Smith-Owen Engineering Company, London. This bridge was designed by J. J. C. Bradfield, chief engineer of the Sydney Harbor Bridge Branch, Department of Public Works, New South Wales. It is being built under his supervision and he is in direct charge of the day-labor work for the approaches.

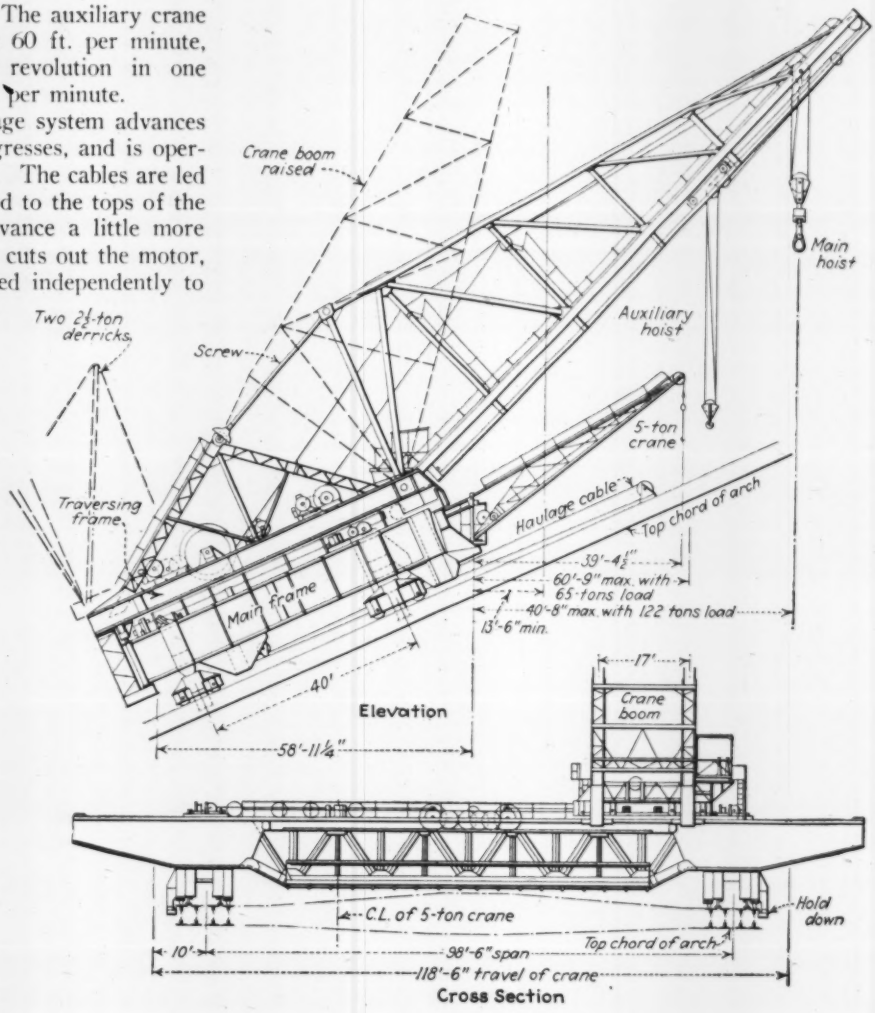


FIG. 7—TRAVELER FOR ERECTING 1,650-FT. ARCH

CONCRETE FOR ARCH ABUTMENTS

	Mix	Crushing Strength, Tons per Square Foot 28 Days	3 Mo.	6 Mo.
Surface of skewback	1 : ¾ : 2½	430	530	545
Next layer	1 : 1½ : 3	280	350	360†
Main mass of abutment*	1 : 1½ : 4	218	...	...

*Main mass of concrete, in hexagonal layers, 130 tons at seven days and 178 tons at fourteen days.
†Intermediate layer, 390 tons at thirteen months.

New York Barge Canal Makes Gains in 1927

The annual report of Frederick Stuart Greene, State Superintendent of Public Works, tells of a substantial gain in canal tonnage over the Barge Canal during 1927, the total being 2,581,922 tons of freight, an increase of 212,525 tons, or about 9 per cent more than the tonnage of 1926, which was the best previous year since the Barge Canal was placed in operation.

The report states that the physical condition of the canal channel and structures has been considerably improved. During 1927 the department plant removed from the canal 1,382,874 cu.yd. of material, and 183,256 cu.yd. of stone and gravel bank protection was placed.

Resistance to Flow in Floodway of St. Francis River

Study Shows Effect of Timber and Underbrush in Checking Flood Flow of Channel 2,500 Ft. Between Levees

By Charles E. Ramser
Drainage Engineer, U. S. Department of Agriculture

Information on the Capacity of floodways is all too meager and while that given by Mr. Ramser relates to depths less than 10 ft., it will be welcomed by those interested in flood control by floodway diversions. None of the velocities approaches those utilized in computing the capacity of the proposed Cypress Creek diversion down the Boeuf River. Velocities there ranged from 0.7 to 1.3 f.p.s., with depths ranging from 12.5 to 20.5 ft., and n in Kutter's formula was assumed equal to 0.15 in all cases of uncleared section. Slopes varied from 0.0004 to 0.00011. In Mr. Ramser's earlier measurements to which he refers the depths were 4.5 to 4.9 ft. in the uncleared section and produced a velocity of 0.50 to 0.72 f.p.s., with n equal to 0.077 to 0.079. Slopes ranged from 0.00008 to 0.00016. Plenty of room exists for information of this kind, particularly for greater depths, since all of the proposed floodways in the control of the Mississippi River run above 10 ft. in depth. —Editor.

As part of a study of the flow of water in drainage channels that the U. S. Department of Agriculture has carried on for about fifteen years, measurements were made early in 1927 of flow through standing timber in the St. Francis River floodway in northeastern Arkansas, where the conditions are such as would prevail in considerable parts of the relief channels that have been advocated for preventing damage from floods in the Mississippi River. Similar data were obtained five years earlier on the diversion floodway of the Little River Drainage District in southeastern Missouri. (See *Engineering News-Record*, Oct. 12, 1922, page 598.) The measurements here reported were made at depths of flow ranging from 4.1 to 9.5 ft., and from the observed data there have been computed the corresponding values of the Chezy coefficient C and the Kutter friction factor n.

This St. Francis floodway was constructed about 1922 by Drainage District 7 of Poinsett County, Arkansas, and the experiments described were conducted on a straight course of the floodway 8,000 ft. long about 4 miles northwest of Marked Tree. The water flows between parallel levees about 12 ft. high and about 2,500 ft. apart. At either side, and within the floodway, there is an open channel about 50 and 70 ft. in bottom and top width and 11 ft. deep. Between the channels the floodway is covered with virgin timber. In most places the course is practically free from undergrowth, but there are occasional dense patches of small trees and bushes. Logs and dead fallen trees are scattered throughout the floodway.

Discharge measurements were made at the railroad bridge of the Chapman & Dewey Lumber Company, midway between the ends of the slope course, in order to obtain as nearly as possible the average discharge through the floodway at a single gaging section, since there was some flow of water back and forth between the timbered area and the open channels. To eliminate as far as possible any accelerating influence of the higher velocities in the open channels upon the lower velocities through the timber, measurements and computations were made for only that portion of floodway situated between lines 250 ft. from either levee, a total width of 2,000 ft.

Velocity was measured with a current meter at intervals of 50 ft. across the floodway. It was measured at

FIG. 2—LOOKING UPSTREAM FROM GAGING STATION
The tangled brush and timber keep down the velocity.

FIG. 1—SLOPE COURSE OF ST. FRANCIS FLOODWAY
Looking into floodway from upstream of gaging station, 600 ft. from east levee.

FIG. 3—2,000 FT. FROM UPPER END OF COURSE
View from levee into floodway covered with virgin timber consisting of oak, cypress, cottonwoods and many others.

FLOW IN ST. FRANCIS RIVER FLOODWAY
Hydraulic Elements and Values of n in Kutter's Formula

Date, 1927	Average Depth, Ft.*	Discharge, Sec.-Ft.	Average Cross-Section, Sq.Ft.	Mean Velocity, F.P.S.	Slope of Water Surface	C in $V=C.\sqrt{RS}$	n
Feb. 2	9.46	11,748†	18,918	0.621	0.0001215	18.3	0.152
Feb. 4	9.40	11,434†	18,808	0.608	0.0001146	18.5	0.150
Jan. 31	8.88	10,648†	17,752	0.600	0.0001227	18.2	0.149
Feb. 17	7.86	8,650†	15,710	0.551	0.0001049	19.2	0.134
Feb. 18	7.77	8,907‡	15,540	0.573	0.0001050	20.1	0.127
Feb. 20	7.48	8,707‡	14,968	0.582	0.0001054	20.7	0.121
Feb. 21	7.34	8,368‡	14,688	0.570	0.0001028	20.8	0.120
Feb. 22	7.19	7,751†	14,384	0.539	0.0001029	19.8	0.125
Feb. 23	7.07	8,205‡	14,134	0.581	0.0001030	21.5	0.114
Feb. 25	6.76	7,383§	13,522	0.546	0.0001030	20.7	0.116
March 6	4.97	4,613†	9,932	0.464	0.0001042	20.4	0.104
March 8	4.57	4,059§	9,134	0.444	0.0001056	20.2	0.102
March 9	4.41	4,126‡	8,828	0.467	0.0001036	21.8	0.093
March 10	4.16	3,901‡	8,312	0.469	0.0001042	22.5	0.088
March 13	4.08	3,528†	8,152	0.433	0.0001061	20.8	0.095

*The average depth is also the hydraulic radius.
†Determined from three-point measurements of flow.
‡Determined from surface measurements of flow.
§Determined from a combination of three-point and surface measurements of flow.

top, middle and bottom depths for seven of the gagings and at the surface for six gagings, while a combination of the two methods was employed for two gagings. Coefficients used to reduce the surface velocity to the mean velocity in the vertical were obtained from the three-point gagings. The slope of the water surface was carefully measured on the east side of the floodway. Cross-sections were measured at intervals of 1,000 ft. along the slope course, the bottom of which was fairly even and regular, with occasional flat-bottom sloughs, but there was considerable variation in the cross-sectional area. At the highest stage measured the average depth for single cross-sections ranged from 93 to 105 per cent of the average depth for the length of the slope course. For the lowest stage measured the range was from 85 to 112 per cent of the average for the course.

In the accompanying table are given the hydraulic elements and values of n obtained for the floodway. Under the conditions described the hydraulic radius is equal to the average depth. The values obtained from three-point gagings and from the combination of three-point and surface gagings, which are indicated in the table, are more accurate than those obtained from only surface gagings. Values determined from the more accurate gagings show a continuous decrease in n from 0.152 for the highest stage at an average depth of 9.46 ft. to 0.095 for the lowest stage at an average depth of 4.08 ft. The values determined from the surface gagings, considered separately, likewise show a continuous decrease with depth, although they average slightly lower than the other group. It is believed that this decrease in n with decrease in stage is due to the fact that fewer branches on the trees were encountered by the flow at the lower stages.

FIG. 4—2,000 FT. FROM LOWER END OF COURSE
Decrease of n with decrease in stage is attributed to fewer branches encountered at lower stages.

It appears that the value of n for high stages in this floodway could be reduced appreciably by cutting all branches that will be submerged at the highest stage of the water. A further reduction in the value of n could be accomplished by clearing out all small undergrowth, logs and fallen trees. The discharge capacity of this floodway for the highest stage given in the table was computed, using a value of n of 0.046, as obtained for the cleared course of floodway in the Little River Drainage District, in Missouri, from which it appears that the capacity of the St. Francis River floodway could be nearly tripled by clearing off the timber and undergrowth.

This investigation was made by the writer, under the direction of S. H. McCrory, chief of the division of agricultural engineering, Bureau of Public Roads, U. S. Department of Agriculture.

Big Grade Separation and Union Passenger Station Project for Oklahoma City

After some years of negotiation, agreements have been effected between the railways and the city authorities of Oklahoma City, Okla., for relocation and elevation of tracks and the construction of a union station. The railways are on separate and private rights-of-way through the city, with three track crossings at grade, so that any improvement must include all the lines as a unit railway system. The four principal railways are the Santa Fe, the St. Louis-San Francisco, the Rock Island and the Missouri-Kansas-Texas. Of these the first two use the same station; each of the others has its own station.

The city has agreed to purchase for $4,000,000 the right-of-way and other property owned by the Rock Island and the St. Louis-San Francisco through the main part of the city, the railways to relocate and divert their tracks to the southern part of the city, or south of the main business section, and to build a joint passenger station to cost not less than $2,000,000. They are to separate the grades in the principal streets by building three viaducts over the tracks, and a fourth viaduct in the near future when traffic conditions are found to require it.

The Santa Fe Railway has agreed to elevate its tracks from about ½ mile north of the wholesale section through to the southern part of the city, providing street subways and paying for all this improvement except those portions of the subways outside the right-of-way. The city agrees to provide a storm-water sewer to take care of the drainage along this track elevation. The Santa Fe Railway has agreed also to construct a new passenger station, but the cost of this station has not been specified.

By this agreement the railways have two years in which to carry out the work. The railway companies, the city officials and the planning commission are now securing the rights-of-way that are necessary for the track changes.

Memorial Tower Built to Last Through Ages

Granite and Concrete Building 330 Ft. High Supported on Reinforced-Concrete Mat 9½ Ft. Thick—Main Part of Tower Carried on 24-Ft. Girders at Third Floor

By Charles Carswell,
Structural Engineer, Washington, D. C.

THE George Washington Masonic National Memorial, now under construction at Alexandria, Va., is noteworthy for the general massiveness of its construction, for certain features of its structural design, arising both from architectural requirements and from the conception that the building be of enduring character, and for details of the construction work.

The memorial is designed as a temple, with architectural motif derived from the Ziggurat towers of antiquity. It faces east, and is located upon the summit of a hill on a 36-acre tract. The main structure, 225 ft. long by 164 ft. wide and 104 ft. high, will be surmounted by a series of four successively smaller temples, each designed in classic architecture. The entire structure is faced with ashlar granite. It will rise to a height of 333 ft. above its base.

The fundamental conception upon which the structural design is based is that the memorial shall remain in place for thousands of years. Accordingly enduring materials, principally granite and reinforced concrete, have been adopted for all the structural parts. Metal work is used only incidentally, as furniture and fittings, the ornamental covering for the tower roof being the nearest approach to the use of structural metal. The entire construction is of massive proportions. Structural walls 4 ft. thick are used for the support of the tower. All outside walls are 2 ft. 6 in. thick in the lower tiers and 2 ft. thick in the upper tiers. The granite facing and the structural granite is hard New Hampshire stone. All the ashlar facing has been specified to have beds of 4 and 8 in. minimum depth, and all of the stones placed to date have beds averaging nearly twice the dimensions specified.

A large hall will occupy the entire central area of the main structure beneath the tower. The other portions of the main building and the upper floors in the tower will provide lodge meeting rooms, library and museum rooms and offices. All floors are designed for live loads of 100 lb. per sq.ft. and all roofs for 40 lb. per sq.ft.

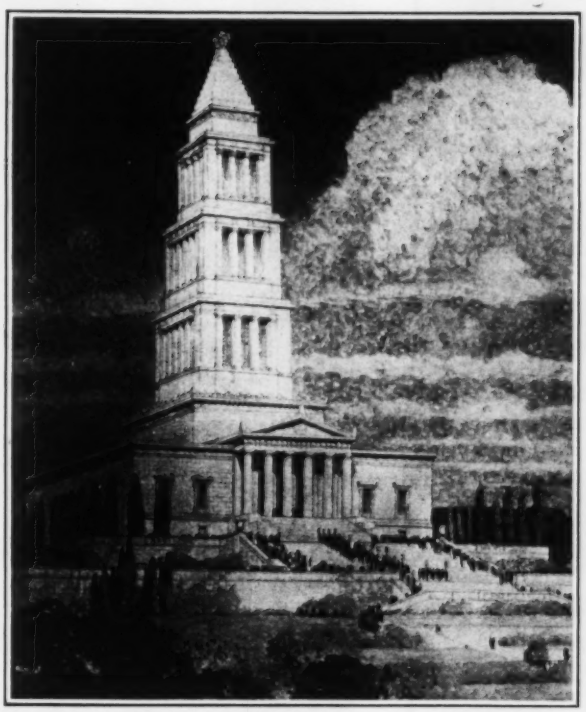


FIG. 1—GEORGE WASHINGTON MASONIC MEMORIAL
The building, 333 ft. high, consists almost wholly of granite and reinforced concrete. It was planned as an enduring monument.

Foundations—The ground at the site of the memorial consists of a thin capping of gravel, underlain by clay to a depth of about 100 ft. The foundations rest upon the clay and consist of a continuous reinforced-concrete slab covering the entire area beneath the building. Foundation upon the clay was adopted after study of conditions at the site and examination of the material by borings and by laboratory and field tests. Investigation by excavation and test borings showed that the upper portions of the clay were dry and extremely hard, and the lower portions dense but containing moisture. Samples obtained at 20 to 30 ft. below the foundation level were plastic enough to be worked easily by hand. The topog-

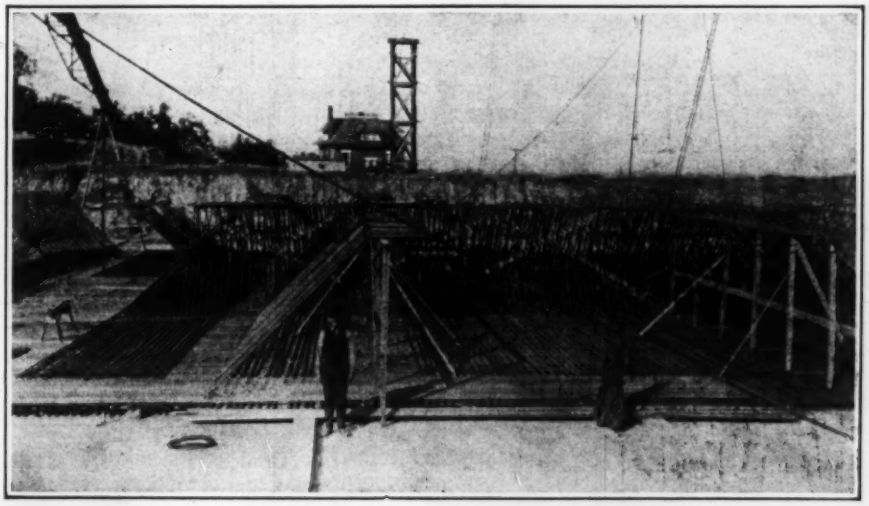


FIG. 2—REINFORCING STEEL IN FOUNDATION MAT
In the foreground is the 3-in. protective mat with monolithic ribs for supporting the reinforcing steel.

raphy is such that the slopes away from the site gave drainage to the upper portion, so that, with the building in place and drainage installed in the surrounding ground, the entire mass of clay forming the upper levels will tend to become drier.

Laboratory tests were made on samples of clay taken at the level of the foundation bed (about 20 to 30 ft. below the original summit of the hill). These samples show loss of weight by drying of 21 per cent and shrinkage in volume of 6½ per cent. The plasticity of the material was tested by placing a cylinder inside a pipe in which holes of ⅛-in. diameter had been drilled and then applying pressure by a loosely fitting plunger, the material being free to flow through the holes and up around the plunger. No plastic flow occurred under loads up to 16 tons per sq.ft. A cylindrical sample 4 in. in diameter and 3⅞ in. high, tested for resistance to compression when unconfined, withstood 4 tons per sq.ft. before failure by cracking. These tests indicated that the clay afforded adequate resistance to compression even when unconfined and that, when confined, a load many times the intensity required for the building could be supported without causing plastic flow.

For the field tests, circular bearing blocks of concrete inclosed in metal rings and bedded carefully on the clay were loaded with steel rails. Four sizes of blocks were used, areas of ¼, 1, 4, and 9 sq.ft. Lag screws driven into the ground in radical lines around each bearing block indicated the amount and extent of movement of the clay adjacent to the block. In each case the loads were applied continuously from zero until settlement prevented continuation of loading. At the portion of the site where the clay seemed softest, the settlement of the blocks averaged less than ½ in. under loads of 3 tons per sq.ft. and where the material was harder, settlement under similar conditions averaged less than ¼ in. with periods of fifteen hours under load. As the loads were increased above 3 tons, the clay began to flow laterally, as evidenced by upheaval and cracking in the surface adjacent to the bearing blocks; the block then settled rapidly, sometimes tilting. It was evident during these tests that any distributed load over the area adjacent to the blocks would have retarded or prevented the lateral and vertical displacement which permitted rapid settlement. Interpreted with regard to the design of the building, where edge loads on the foundation slab and the load of backfill around the building furnish restraint, these tests indicate that the clay is capable of supporting loads greatly in excess of the test loads without objectionable settlement and without producing any uplift.

The foundation slab is 9½ ft. thick in the central portion under the tower, reducing to 4½ ft. outside this area and then to 2 ft. at the edges beneath the exterior walls. The entire slab is of 1:2:4 gravel concrete and contains 8,794 cu.yd.

The principal loads from the building are brought upon the foundation by the structural walls supporting the tower. The loads from the exterior walls and steps are relatively light (less than 1 ton per sq.ft.), making the average load under the entire foundation mat 2 tons per sq.ft. No load is applied on the area inside the columns in the central portion of the structure.

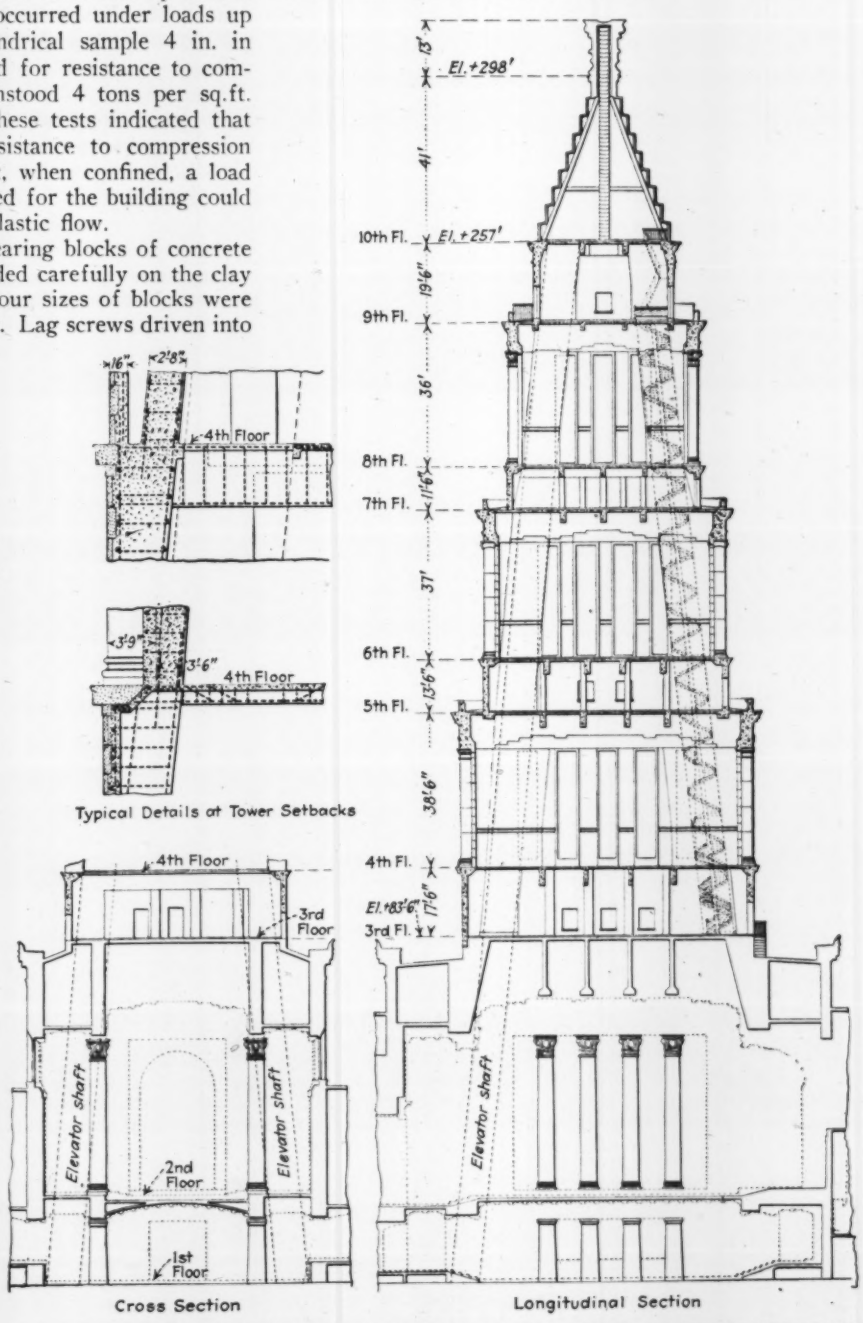


FIG. 3—REINFORCED-CONCRETE FRAME, GEORGE WASHINGTON MASONIC MEMORIAL

The slab is reinforced to resist bending stresses that may occur from inequalities in clay settlement and to make the entire foundation slab continuous, so that the building, together with the backfill surrounding it, will effectually confine the underlying clay and preclude the possibility of lateral movement or uplift. The slab was designed and constructed as fifteen interconnected monolithic units separated by predetermined construction joints, located to serve as expansion joints without decreasing the strength of the mat. The main reinforcement consists of seven layers of 1¼-in. square bars spaced 4½ in. on centers, the bars extending both ways in each section and tying the sections together. In addition the sections are hinged together at each joint by Z-bar reinforcing, extending in each direction and crossing at the joint.

As special protection for the foundation bed, to preclude the possibility of damage either by oxidation or from storms, a 3-in. mat of concrete was placed on the subgrade as it was uncovered. Excavation first was made to 1 ft. above subgrade. Then as the steam shovel made the final cut the protective mat was poured. Concreting followed the shovel so closely that no part of the bed was exposed to the air for more than 30 minutes, the shovel being run ahead and the protective mat placed to the full extent of the cut at the end of a day's work. Ribs formed in this protective mat gave support for the foundation slab reinforcing steel and the raker timbers used to brace the forms.

Structural Design—All walls are designed to secure direct thrust throughout the structure, the interior faces being sloped, or special construction provided, to afford direct thrust for the successive tiers of the tower as they set back upon one another. At certain levels, as at the fifth floor, this construction results in the use of inclined structural walls entirely independent of and separate from the outside walls of the tower; the outside wall in these cases serves only to support the stone facing. In addition to the provisions for direct thrust through the successive tiers of the tower, special provision has been made by the use of diagonal reinforcement in the walls to insure uniformity of distribution in transmitting girder loads to the walls.

The most involved features of the structural design arise from the architectural requirements for the large memorial hall in the center of the building and for the construction of the tower directly over this open hall, rising 250 ft. above the roof of the hall. The hall is 66 ft. wide between structural walls on the north and south, with a total length of 110 ft. The clear space in the center is 35 ft. 4 in. wide by 65 ft. long. Concrete piers are provided at each corner of this clear space, and on the north and south sides, between these piers, four polished granite columns are placed, these piers and columns acting in conjunction with the structural walls as support for the tower.

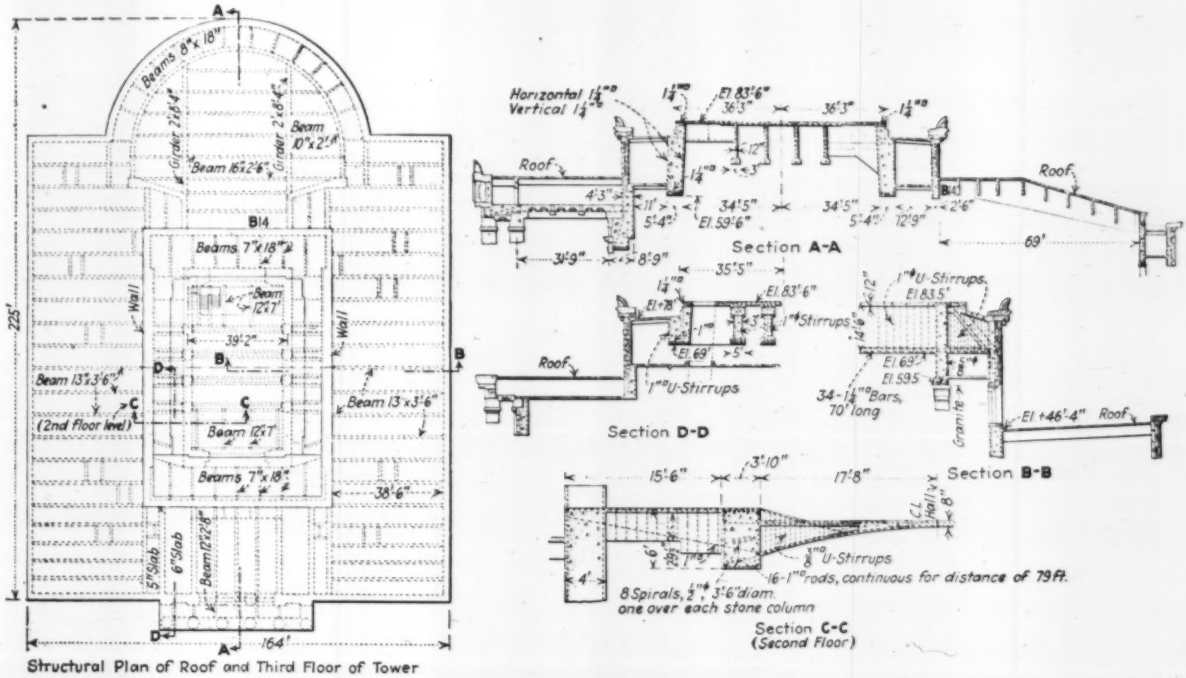


FIG. 4—STRUCTURAL FRAMEWORK SUPPORTING TOWER AT THIRD FLOOR LEVEL

The columns are in two tiers, one from the foundation bed to the under side of the second floor girders, and a second tier extending 40 ft. above the second floor to girders which form part of the third floor system directly supporting the tower construction. The columns are 4 ft. 2 in. in diameter, designed to carry 1,000 lb. per sq. in. Column continuity is provided through the girders at the second floor between the granite columns of the tier below and that above by the introduction in the girder reinforcement of 3 ft. 6 in. spirals of ½-in. diameter rods. Similar spirals are inserted in the girders of the third floor system over each column.

The girders at the second floor are designed as cantilevers (Sec. *CC*, Fig. 4) with reinforcement extending beyond the columns to the structural walls at the sides of the hall. This type of construction was adopted in preference to an earlier arch design in order to secure a minimum of deflection at the center of the floor of the hall.

The two lines of columns are spaced 39 ft. 2 in. center

to center, and the columns are 10 ft. 5 in. center to center in each line. Extending in an east and west direction over the tops of the columns and the corner piers in each line is a concrete girder 3 ft. 4 in. wide and 24 ft. deep. (Sec. *BB*, Fig. 4). In the north and south direction (Secs. *AA* and *DD*, Fig. 4) a beam 5 ft. 4 in. wide at the bottom, 9 ft. wide at the top and 24 ft. deep extends across the end piers, while over the tops of the columns and the structural walls of the hall are four girders 14 ft. 6 in. deep, with soffits 5 ft. wide between the columns and the structural walls and 3 ft. wide in the central portion between the two lines of columns; the webs of these girders are respectively 3 ft. wide and 1 ft. wide. The slab over the entire area is 12 in. thick. These girders, beams and slab constitute the third floor system, upon which the tower is supported.

The 14 ft. 6 in. girders perform the heaviest duty. They are reinforced with 34 1¼-in. square bars, 70 ft. long between bends (Sec. *BB*, Fig. 4), with 5 ft. on each end turned up. This length of bar was adopted in order to avoid the extra handling and splicing and difficulty in placing concrete required with the use of shorter bars. The stirrups in these girders are 1-in. round bars. Under ordinary conditions the weight of the tower is distributed between the granite columns and the structural walls, the girders serving only to support the third floor loads and to contribute to the lateral stiffness of the entire frame. The girders are designed, however, so that in the event of disturbance of the granite columns by earthquake, the entire weight of the tower can be supported by them and transferred to the structural walls at the north and south sides of the hall. The 24 ft. girders over the columns are caps for support of the ceiling construction. They contribute to the longitudinal stiffness of the building and furnish additional girder strength for transferring loads equally to the transverse girders and the walls in the event of disturbance of part of the columns.

The girders and slab forming the third floor system represent an unusually heavy piece of construction. The total volume of concrete is 1,153 cu.yd. Each of the 14 ft. 6 in. girders with its portion of the slab weighs 198 tons. The total concrete in this portion of the construction is equivalent in volume to a 3 ft. 9 in. slab over the entire area, and represents a dead load in contact with the forms of 2,300 tons. The extreme outside portions, which act only as a roof, were supported during construction by ordinary T-props, but special provision was necessary for the forms in the central portion. Here the beams and slabs were supported upon 24-in. beams seated upon corbels worked into the structural walls. Two beams were used beneath the soffit of each of the transverse reinforced-concrete girders. The forms for the webs of the girders and for the slabs were supported on these steel beams, but were constructed so as to be independent of one another. After the concrete work was completed and the forms were stripped, the steel beams were removed by burning off at the wall corbels.

Elevators in Inclined Shafts—Another unusual problem resulting from the architectural arrangement inside the building is the provision for elevator service to the tower floors in inclined shafts. Two shafts are provided, placed symmetrically at each side of the hall, on a pitch of approximately 1 to 12.

Construction Work—Construction was started under a contract covering only the foundations. The plant designed and built for this contract consisted of a concrete plant and chuting tower located at the south side of the main building. Before the foundations were completed the same contractor was retained for construction of the superstructure, and it was found possible to adapt the plant and equipment already in place to the handling of the entire work. An auxiliary chuting tower was erected in the center of the building, an opening being left for it at each floor, to be filled after the building has been constructed to full height. This central tower is equipped with two booms for handling granite and falsework materials.

All excavation has been handled by steam shovels. With 30,000 cu.yd. of material removed from the foundation, 105,000 cu.yd. from the approach steps and terraces and 55,000 cu.yd. yet to be removed, excavation will total 190,000 cu.yd.

Construction work on the foundation mat was handled on a continuous basis, the shortest run being seventeen hours and the longest 99 hours. A total of 302 hours, in six runs, was required for the mat, and with only six hours in the entire period lost for repairs and oiling. The center section of the mat was placed first and allowed to set for seven days before the forms were removed; then the other sections were concreted alternately, the forms in each case being removed at the end of one week.

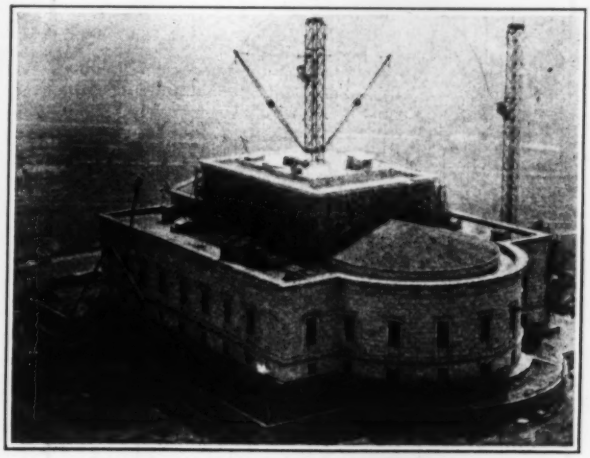


FIG. 5—BEGINNING THE 250-FT. TOWER AT THE THIRD FLOOR LEVEL
Center elevator tower, equipped with two booms, handles all granite, forms and reinforcing

At the western end of the building the exterior wall is a semicircle in plan, forming the outside wall for an auditorium directly back of the central hall. The construction of the roof over this auditorium presented a special problem, for although it is of slab and girder construction, the slab is the surface of a cone of 40-ft. diameter and 14-ft. rise and the soffits of the beams grade toward the outer edge. The slab is 4½ in. thick and is supported on beams framing into two main girders, each 2 ft. thick and 8 ft. 6 in. deep at the ends and 12 ft. 6 in. deep at the center. Top forms were necessary to hold the concrete on the pitch of this roof. These were constructed by placing supporting rafters to the grade for the finished surface and then inserting boards, previously cut to exact size and fitted with nailing strips, between the rafters and spiking them in place. The slab and beams and girders contained 280 cu.yd. of concrete and were poured continuously in eighteen hours.

Personnel—The building is being built by the George

Washington Masonic National Memorial Association, Louis A. Watres, president, and J. Claude Keiper, secretary-treasurer. Helmle, Corbett & Harrison, New York City, are the architects, with Osgood & Osgood, Grand Rapids, Mich., consulting architects. The Gunvald Aus Company, New York, is consulting engineer for the structural design of the building and Daniel E. Moran, New York City, was consulting engineer on the foundations. The Cranford Company, Washington, D. C., is the general contractor.

Steam, Air and Water Jets Help Caisson Sinking

Concrete Caisson 40x21 Ft. for Mine Shaft Sunk by Excavating, Loading and Use of Jets

IN SINKING a new concrete lining for a coal-mine shaft at Nason, Ill., steam jets were used to loosen the material when the shaft was hung up by friction and water jets proved insufficient to release it. This shaft, at a mine of the Illinois Coal Corporation, was sunk in 1923 and has been used as an air shaft. For a depth of 49 ft. it was about 14½x33½ ft. and was built of a solid curbing or lining of 6x12-in. timbers on edge. At this depth water-bearing sand was encountered, and 14-in. interlocking steel sheet-piling was driven to rock at about 80 ft. depth, within which the excavation was carried down. The piling pushed inward at the bottom so that the clear opening was about 10x30 ft. There was continual leakage of water through the sheet-piling, with a little sand, but above it there was very little leakage.

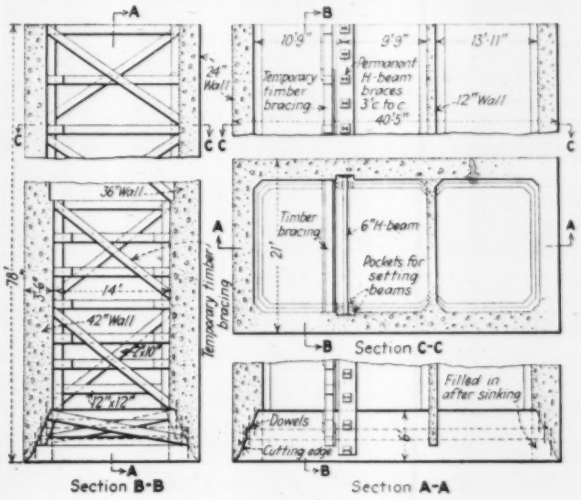
Bulging of the steel sheeting became apparent in 1926. The timber lining also showed signs of being overstressed, and the owners reinforced it at the corners with 6x6-in. kneebraces about 7 ft. long, spaced 15 to 36 in. c. to c. As this proved ineffectual, a permanent reconstruction was decided upon in order to save the shaft. The plan adopted was to sink a concrete caisson from the surface to the rock. This structure is 21x40½ ft. over all, with interior corners beveled and with a 12-in. cross-wall forming an airway. After the shaft was sunk, the larger opening (for the cages) was divided by crossbracing of 6-in. H-beams or buntins, spaced vertically 3 ft. c. to c. From a sharp cutting edge the side walls tapered to a thickness of 42 in. at a height of 6 ft. Above this they were 42 in. thick for 24 ft., then 36 in. for 24 ft. and 30 in. for 24 ft. to the top, the total height being 78 ft.

Construction was begun in July, 1927. The cutting edge was built in a 12-ft. excavation, and above this the concrete was poured in 6-ft. lifts, with two sets of panel forms used alternately. When the caisson had been built to 24 ft. above the cutting edge, the pit was backfilled and sinking was begun (Sept. 4). At a depth of 44 ft., however, the shaft refused to sink.

After the cutting edge had been undermined and backcut, the 54-ft. height of concrete was increased to 70 ft., and platforms were built on the offset at 54 ft. and loaded with 200 tons of clay. In addition, 285 tons of steel rails was loaded on the top, making a total added weight of concrete, clay and rails of 735 tons. Yet the shaft did not move.

Water jets were then tried, the shaft being kept vertical by means of guide shores of 12x12-in. timbers. Two 2-in. jet pipes were used, with ½-in. nozzles and 175-lb. water pressure. Both were worked from a derrick boom, being raised and lowered alternately by the hoisting engine. Starting with a 5-ft. drop after the jetting had been carried entirely around it, the shaft continued to sink as material was excavated, but it stopped again when the cutting edge reached a depth of 68 ft. Further jetting with water and air proved ineffectual.

Steam jets were then resorted to. The material around the shaft was first excavated to a depth of 20 ft., and with the same pipes previously used for the water jetting steam jets at 175-lb. pressure were applied. Some water was necessary also in order to form sufficient mud around the jets. This process was carried on for



CAISSON FOR MINE SHAFT

24 hours daily for five days, when the shaft started to move slowly, sinking at the rate of about ½ in. per hour. At the same time, 1-in. air jets at 100-lb. pressure were worked under the cutting edge. Interruptions were necessary to allow of removing the steel sheeting, which had to be cut apart and taken out in very short lengths, 2 or 3 ft., in order to avoid an inflow of the quicksand.

During the sinking the larger compartment of the shaft was crossbraced by 12x12-in. timbers 3 ft. apart, with vertical diagonal plank bracing on each side. This timbering was at one side of the position for the permanent steel H-beam buntins, and was removed after the latter had been placed. These buntins have 12x12-in. anchor plates at each end, embedded in the wall. Pockets for these plates were left in the side walls during the original pouring, and these pockets were afterwards packed with concrete.

On Nov. 11, 1927, the shaft was landed successfully on the shale rock, making an average sinking rate of 14 in. per day. The entire work, including the erection of a steel headframe, was completed on Jan. 5, 1928. The work was done by the Foundation Company under the direction of F. W. Adgate and L. J. Hotchkiss, of the Chicago office. L. J. Ruddock was superintendent. The Allen & Garcia Company, Chicago, acted as engineer for the Illinois Coal Corporation.

Equipment Costs for Gravel Road Maintenance

Operating Expenses of Maintenance Equipment as Determined by Close Accounting in Gogebic County, Michigan

C. F. WINKLER
Engineer-Manager, County Road Commission, Bessemer, Mich.

Extracts from a paper at annual Michigan conference on highway engineering at the University of Michigan, Ann Arbor, Mich., Feb. 14-17, 1928

THE following cost and performance records are from actual experience in Gogebic County, in northern Michigan, and are the result of careful accounting and personal supervision and contact. They are not assumed to represent experience in other sections of the state.

Tractor Bladers—A few years ago a gravel road maintenance section was about 7 miles long and was maintained by a small drag or grader drawn by horses. This equipment soon proved inadequate, because of the limited mileage and its lack of weight. The next step was the substitution of farm tractors for horses, and use of graders heavy enough to cut the road metal. These outfits, although much cheaper than team labor when mileage and class of work were considered, ran up an enormous repair bill for the tractors, besides requiring two operators. The costs for this type of tractor were on the average 80c. per running mile. To this cost was added the cost of the grader and its operator. This class of machine averaged about 20 running miles per day and maintained approximately a 10-mile section.

Then manufacturers produced the one-man, tractor-operated patrol grader on rubber-tired wheels. This machine is an economical and efficient patrol unit. One unit is capable of maintaining 20 to 25 miles of road. It is economical because of low first cost, low repair cost, the large mileage and the one-man operation. It is efficient due to its weight and ease of control and because it can be used for scarifying. These machines will operate for about $11.75 per nine-hour day and will travel, on a year's average, about 30 miles per day at a cost of less than 50c. per mile. Compared with the steel-wheeled farm tractors drawing graders, the dragging cost has been cut 50 per cent per running mile, the mileage covered has been increased from 18 to 30 miles per average day and the character of the work has been greatly improved.

Motor-Truck Bladers—Motor trucks with spring blades proved quite efficient and economical with the army trucks, where the first cost was very low and the consequent daily rental or depreciation rate was a minimum. The heavier trucks, however, when purchased new, cost approximately four times the amount of the patrol graders. Granting that the repairs are less, one truck, to compete in cost with a patrol grader, must cover at least the same mileage as two patrol graders, or must be able to maintain a section 50 to 60 miles long. The truck will easily cover this mileage, but dragging carried on at this speed in ordinary dry weather is not efficient and will not eliminate irregularities and cut off chatter bumps.

A cheaper truck must be purchased to compete with a tractor patrol girder. A truck of 2-ton capacity, costing $2,500, may answer the purpose, but because of its lightness and its inability to scarify rough stretches of road, will need the assistance of a tractor-operated machine at intervals. The cost of operating a $2,500 truck with a spring blade is about $18 per day, as compared with $11.25 per day for a tractor patrol grader. The truck, then, must cover at least 50 per cent more road and must maintain a section of road from 40 to 50 miles long. This is quite a maintenance section for one truck.

Team Hauling—Another major maintenance task on gravel roads is transportation of materials. Horse-drawn vehicles in some instances are used on hauls up to 2 and 3 miles in length. This method of handling gravel or any road material for road maintenance has no defence from a standpoint of economy, except possibly where a sleigh-haul can be utilized. The average ton-mile cost for team and wagon is about 60c. The average ton-mile cost for sleighs where large loads of 3 to 4 tons can be handled is not less than 25c. per ton-mile. When the slowness of the work and the inability to dump loads are considered, even under most favorable conditions team haul is not economical.

Trailer Hauling—Tractors and trailers are used in some instances on the longer hauls and are an improvement over horse-drawn vehicles. However, under ideal conditions and for hauls not exceeding 2 miles in length, a tractor hauling three 5-ton trailers cannot haul for less than 22c. per ton-mile.

Truck Hauling—Trucks have become almost universally used for hauling materials for road maintenance. Army trucks, so cheaply sold to counties after the war, were a decided means of introducing truck haul and supplanting team haul. These trucks were of all types and descriptions and mostly on hard tires. The depreciation charge-off was small, being about $300 to $400 per year, but repair costs were always excessive. In using 5-ton trucks, the ton-mile cost over a period of years was 17.1c. These figures show a decided saving over other types of hauling equipment.

This saving was so encouraging and the use of large-capacity trucks so apparently satisfactory and economical that Gogebic County has for its new equipment large-capacity, high-powered, high-speed trucks. Although these trucks are comparatively new, the running-mile cost, the ton-mile cost and the daily average mileage seem to justify, at least by comparison with the army type truck, their continued use from a standpoint of economy. The average daily mileage of the army type trucks over a period of six years was 44.6 miles, the ton-mile cost, as before stated, was 17.1c. and the cost per running mile 41.9c. Using the newer trucks of 5-ton capacity, on dual pneumatics, costing $8,000 or more, with depreciation figured on a five-year life, the costs are as follows: Ton-mile cost, figured over a period of two years, 14.3c.; daily average mileage, 60; cost per running mile, 37.5c. These figures are all averages, figured on a basis of working days and tons hauled and include all items of operation, insurance, depreciation and repairs, with the exception of office overhead. The high-speed, high-cost trucks show a gain of 35 per cent in mileage per day over the low-cost, slower trucks, a saving of ton-mile cost of 16 per cent and a saving per running mile of 10 per cent.

The roads maintained as county roads are today as a rule more or less improved and, having a compacted base, carry large loads. A 5-ton truck on pneumatic tires will travel with full load at a speed from 20 to 25 miles per hour, depending on the grades, and will carry twice the

amount of a 2½-ton truck at a very slight increase in operating cost. For spring maintenance and other jobs of minor size, such as patrol-section patching, a few of the smaller trucks are necessary.

Screening and Crushing Plants—The preparation of surfacing material for gravel roads is an important item of maintenance. There are numberless deposits of gravel for road surfacing, providing they are crushed and screened to meet specification. Years ago, when the use of 1-in. or 2-in. screen gravel was considered a luxury, when in many counties the expenditure of $12,000 or $15,000 for a crushing plant would have been considered robbery, small portable screening plants were introduced. These plants were equipped to screen from the pit run the size of gravel wanted, and the oversize was rejected and hauled back into the pit. Gravel was scraped out of the pit with wheeled scrapers and dumped into a trap on to a conveyor belt. This was an inefficient way of handling material, and thousands of yards of good road gravel was rejected and wasted. Although the writer operated such plants, figures are not available as to production costs, but about 75c. to 80c. per cubic yard of screened material produced would be a fair approximation.

Gravel crushing and screening plants are therefore a necessity if gravel roads are to be cheaply resurfaced. The application of resurfacing gravel is usually limited to 2 or 3 in. loose measure, and a production of 5,000 to 6,000 cu.yd. suffices for quite a stretch of road. In order to keep within an economical haul, frequent set-ups of the crushing plant are necessary, and today there are on the market portable crushing and screening plants that really are portable. Their purchase and use are economy.

A plant having a capacity of 150 to 300 cu.yd. per day can be purchased, with power and with drag scraper, for about $12,000 to $13,000. Since such a plant can be set up for about $275 and dismantled and moved for about $240, it can be shifted two or three times a season and a great saving effected in truck haul. These portable plants are usually equipped with a jaw crusher, and in gravels in which the boulders are close-grained, finely crystalline igneous rocks, the replacement cost of jaws is rather high and the output of the plant limited. Where these conditions exist and where the amount of material to be crushed is about 30 per cent of the whole, a 9x36-in. jaw crusher cannot be expected to turn out more than 135 to 150 cu.yd. per day of 1-in. material. The cost of material of this kind averages 53.6c. per cubic yard.

Wherever a large amount of crushed material is to be used and therefore a long-time set-up with a larger daily capacity is possible, a non-portable or semi-portable plant with a gyratory crusher is advisable. The cost of setting up and assembling such a plant, with an 8-in. gyratory, screens, bins and rejection returns, is about $800. However, the added overhead is soon made up by lower operating and upkeep costs and increased output. The cost of producing material from pits containing 90 to 95 per cent igneous rocks, with about 30 per cent to be crushed, was 45.1c. The amount of oversize material is a decided factor in the cost of crushing.

Mention was made previously that wheel scrapers were used to handle gravel from the pit to the plant conveyor. The cost of moving material in this manner is approximately 16c. per cubic yard. A great improvement over this old method is a drag scraper outfit, set up to drag into a hopper over the conveyor belt and operated by one man. Even with a limited daily output of 175 cu.yd., gravel can be hauled a distance of 400 to 600 ft. at a cost of 8c. per cubic yard. Another great improvement and a decided step toward economical production of crushed gravel is the shaker feeder to equalize the load on the conveyor or feeder belt and to eliminate alternate peak and light loads in the crusher. By keeping the crusher fed continuously at capacity and eliminating entirely peak loads, the output of a crushing plant can be increased nearly 25 per cent.

Weaknesses in Public Sanitation in Indiana

By L. S. Finch
Sanitary Engineer and Director of Water and Sewage Department, State Board of Health, Indiana

Excerpts from a paper read at the annual meeting of the Indiana Engineering Society

WITHIN the past few months a professional engineer in good standing prepared plans for sewage-works to replace an inadequate plant for a public institution in Indiana. Bids were called for, but the authorities specified that bids on any alternative design, proposed by a bidder, would be considered. This let down the bars and a company manufacturing septic tanks for residential use submitted an alternative design which it proposed to build at a cost $3,000 lower than the low bid on the original design, which had called for an Imhoff tank, trickling filters and glass-covered sludge beds.

The alternative design called for 34 residential-type, precast concrete septic tanks in series. No provision had been made for drawing the sludge from any except the two end units, the others being absolutely inaccessible. When the "chief engineer" who was proposing this monstrosity was asked by the writer to explain how the sludge would be removed and where it would be dried if it could be removed, he replied that his tank was so efficient that there would be no sludge to remove or to dry. The writer further questioned this so-called engineer in the presence of the officials who were to award the contract, and forced him to admit that all engineers (professional) who examined his system said it would not work. Nevertheless he maintained that when it was installed they all had to admit that it was working satisfactorily. Unfortunately, the officials took in all this bunk and awarded the contract to him when he offered to a post a maintenance bond covering the first year.

In the operation of water-works, sewage-works and garbage disposal plants in Indiana, too often the superintendent is the town marshal or the village jack-of-all trades. This is particularly true of sewage-works, which are usually expected to run themselves, with only a little moral support now and then from the last man to whom the buck can be passed. During the past year the writer was called by a health officer to determine why raw sewage was being discharged from the municipal sewage-works. This plant, installed in 1913, consisted of a septic tank and contact bed. No sewage was flowing either in or out of the plant, and on examination it appeared quite likely that it had not been in use for several years. The sewage was being bypassed around the plant, probably because the street commissioner, who was supposed to be responsible for its operation, did not want to be bothered.

Quicksand Tunnel Timbered From Needle Beam

Using Light Air Pressure, Contractor Substitutes Needle Beam Bracing for Shield in Sewer Tunnel at Cleveland

By S. H. Murdock
Engineer of Construction, Division of Engineering and Construction, Cleveland, Ohio

A PARTICULARLY successful operation of holding a quicksand tunnel by bracing from a needle beam is now in progress in Cleveland, Ohio. The tunnel is for a sewer, is brick lined and grouted and is not unusual in design or structure. The construction methods are, however, interesting and unusual in the precision of procedure followed.

Location and Structure—The new sewer is a link in the 79th St. sewer district trunk-sewer system shown on the accompanying map. It extends from Wade Park Ave. 4,500 ft. to Euclid Ave., and is being built in two contract sections by the same contractor. Section 1, contracted for Feb. 23, 1927, and begun March 15, extends 2,300 ft. south from Wade Park Ave. Of this length 500 ft. is special-section sewer built in open cut. The remaining 1,800 ft. of Section 1 and all of Section 2, 2,200 ft., are being constructed in tunnel and under compressed air. Section 2 was contracted for July 17, 1927, and was begun Jan. 15, 1928. All construction is to be completed about Aug. 15, 1928. The total contract cost is $640,000, all of which is being provided by general sewer bonds. Abutting property is not being assessed for any portion of the cost.

The sewer was designed by the rational method, using the city of Cleveland rainfall curve and a factor of imperviousness of 0.6. The general design data used were:

Contract section	1	2
Concentration time, minutes	53	41
Tributary areas, acres	1,027	560
Rate of runoff, inches per hour	1.12	1.36
Runoff, cubic feet per second	1,150	760
Grade, per cent	0.3	0.3
Diameter, feet	11½	10
Capacity, cubic feet per second	1,140	790

Inlet time, eight minutes; $N = 0.015$; $F = 0.6$.

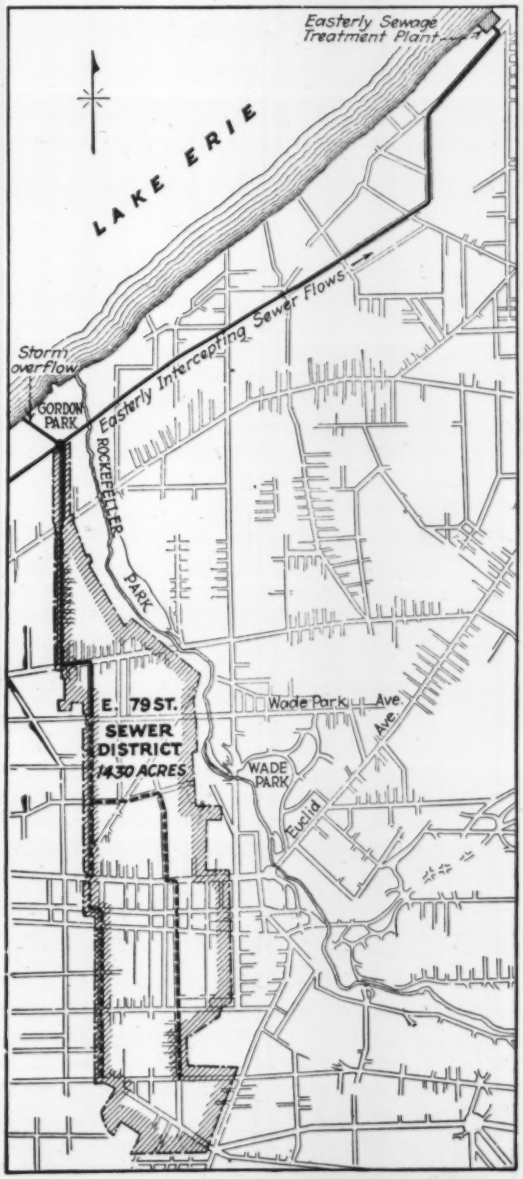
The depths were kept low to be well under future subway or grade-crossing work. Three different cross-sections were adopted as follows:

11½ ft. circular equivalent (special section)	500 ft.
11½ ft. circular	1,800 ft.
10 ft. circular	2,200 ft.
Total	4,500 ft.

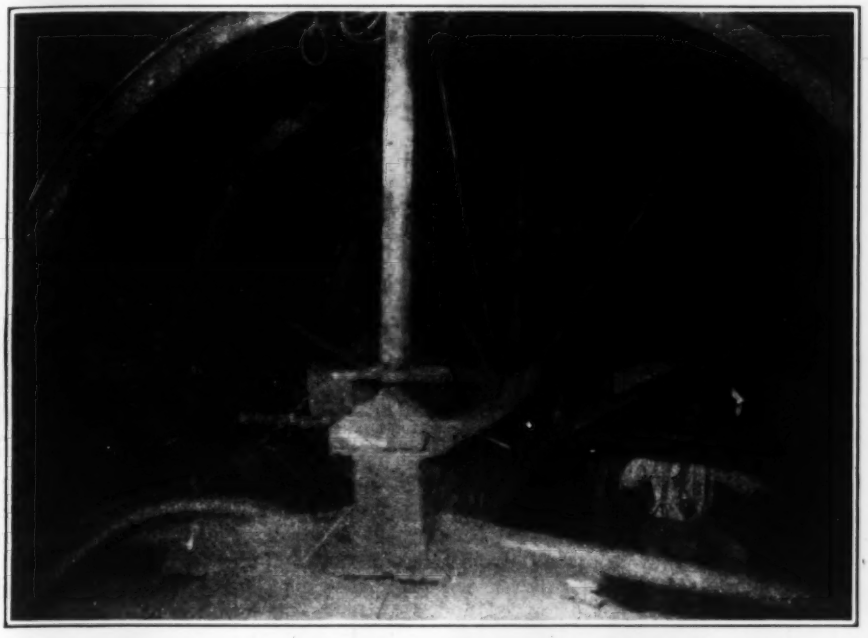
The special section is ham shaped to provide the broad bearing necessary in soil of the character described where open-cut methods are used. The circular sections, 4,000 ft., are constructed in tunnel. All sections are three-ring brick masonry and the special section is laid on a grillage and has a tile underdrain.

Factors Influencing Construction Plan—Borings indicated a surface layer of light yellow sand from 10 to 18 ft. deep. Under this was a deep bed of fine water-bearing sand from 12 to 19 ft. deep. The proposed sewer, at the location and gradient selected, was therefore almost entirely in quicksand. The street is 66 ft. wide. It has many beautiful shade trees, relics of the time when Cleveland bore the proud name of "The Forest City." It is well built up and there are many large residences and apartment houses. Under the street are gas, water, electric light and telephone conduits, and an old sewer, at a depth of about 12 ft., which it was necessary to keep in operation during construction.

Construction in open cut would have involved the tight sheeting of the trench and the relocating of all public service mains. It would also have necessitated rebuilding the local sewers in advance of the work and replacing the pavement upon the completion of the work. In addition to these factors, the street would have been closed to all traffic during construction and the city might have been involved in many damage actions arising from



MAP OF RELIEF SEWER SYSTEM OF 79TH ST. DISTRICT, CLEVELAND, OHIO



NEEDLE BEAM BRACING AND TIMBERING IN QUICKSAND

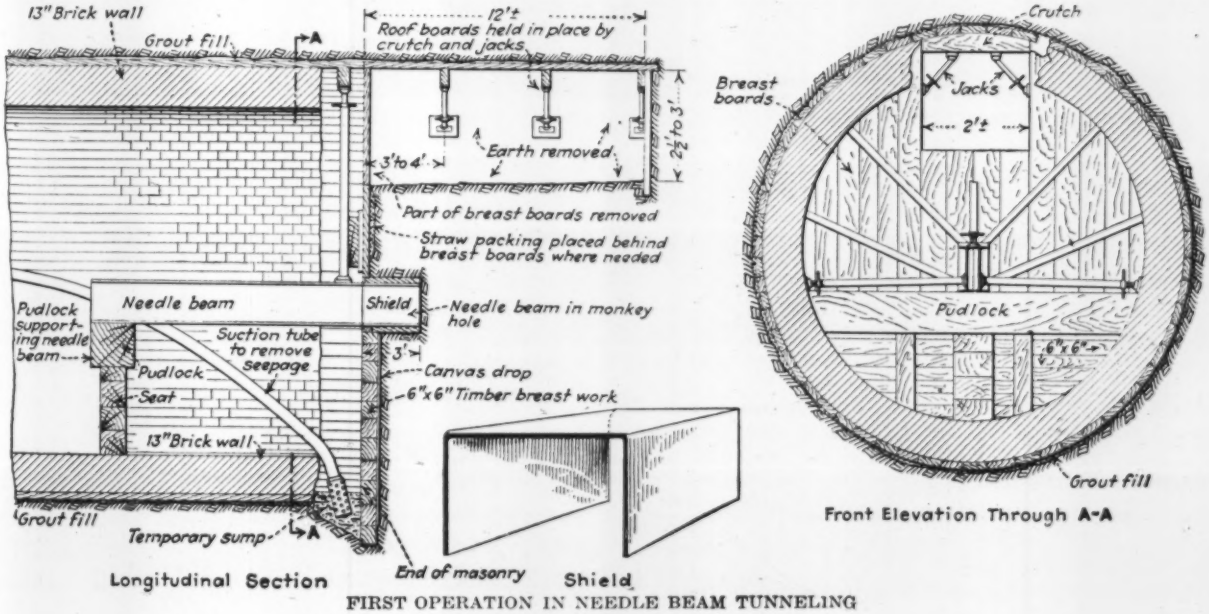
trench settlement. In view of these conditions, it seemed that tunnel construction was the logical procedure and would be the cheapest and best. It was therefore adopted; and to minimize the danger of air leakage the tunnel was located laterally as far as possible from the old sewer.

It was calculated that an air pressure of not to exceed 12 lb. would be sufficient to balance the water in the soil and that this could be consistently maintained without undue leakage or blows. It has been found that a pressure of from 8 to 10 lb. is ample to keep the tunnel dry at all times and there has been little trouble from leakage, although early in the work, while the shallower sections were being constructed, there were occasional leaks at old house connections where the ground had been disturbed and satisfactory cover was lacking.

General Construction Method—Actual methods of construction were left largely to the contractor and were supposed to be governed by conditions as encountered. It was the original intention of the contractor to use a shield, but before starting work he requested permission, which was granted, to brace the excavation from a needle beam. The needle beam used consists of two 12-in. I-beams bolted together with two 3-in. planks between. The planks are carefully trimmed to fit the flanges of the beams and the result is an extremely rigid needle 20 ft. long.

Excavation—Mining operations are begun at about 11 p.m., when the bricklaying on the preceding shift has been completed. A heading is first excavated in the upper half of the bore for a distance of about 10 or 12 ft., which constitutes the average daily shift. The hole thus opened is about 4 ft. wide at the top and 3 ft. wide at the bottom, about 1 ft. below the spring line of the arch. The roof is supported by 3-in. matched sheeting placed longitudinally, which is held in place by diagonal bracing, called crutches, against the undisturbed sides of the heading. Under the air pressure used, the sand assumes the appearance of clay and is quite easily mined and handled. At the point determined as the new face, a hole about 3 ft. long and 2 ft. square is driven into the face, and this hole, known as the monkey hole, is protected by a metal shield.

When the second mining shift comes on at about 7 a.m. the needle beam is moved forward until it has entered the monkey hole to the full depth of 3 ft. The



FIRST OPERATION IN NEEDLE BEAM TUNNELING

beam is then blocked up to line and grade in the monkey hole and also firmly supported at its other end, which now extends into the completed sewer for a distance of about 5 ft. Under normal conditions and when ordinary progress is being made, the needle beam now has a 3-ft. bearing in the monkey hole and a clear span of about 12 ft. in the new section, and extends 5 ft. into the completed sewer, where it is held firmly in place by blocking in the invert and screw jacks against the roof.

Mining operations are now continued downward both ways from the heading already opened, and as rapidly as material is removed, 3-in. matched sheeting, which constitutes the permanent tunnel lining, is placed, being held in place by 6x4-in. blocks cut to proper radius. These blocks are in turn supported by screw jacks resting on the needle beam. The general appearance of the construction at this stage suggests a wheel, the spokes of which are the various jacks radiating from the needle beam, which represents the hub of the wheel. This work is continued all the way around the bore, the invert being the last place excavated. Excavated material is taken by tunnel cars to the shaft, where it is elevated to the tipple and removed at once to the dump.

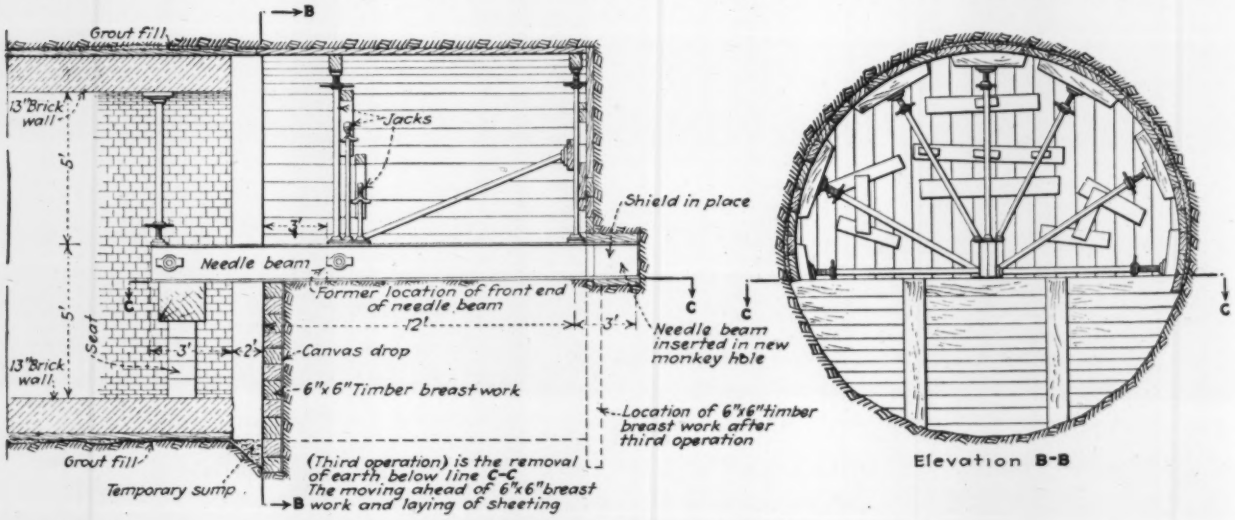
As material is excavated, a tight bulkhead is constructed in the new heading to support the undisturbed earth in advance of the work. The bulkhead consists of breast boards placed tightly against the face from the top of the arch to a point about at the spring line. The lower half of the bore is reinforced by canvas stretched This arrangement eliminates the danger of sand caving it and securely braced upon the completed brickwork. This arrangement eleminates the danger of sand caving in at the face if air pressure should be inadvertently removed.

Lining—Mining is usually completed at about 1 p.m., and shortly afterward the bricklayers begin work. The invert is first set and the masonry is built up simultaneously on each side from the invert. The jacks and bearing blocks are removed as they are encountered. The center roof supports are the last removed and the arch is completed usually at about 11 p.m.

In order to minimize the possibility of air leakage, the contractor forces grout continuously back of the completed brickwork by means of 2-in. pipes built in at frequent intervals. The grout is a mixture of cement and sand and is forced through the 2-in. pipes by a high-pressure compressor. It is, of course, impossible to state just how efficient this grouting is, but it is felt that most of the openings that are undoubtedly left behind the tunnel lining are satisfactorily filled and that danger of air leaks is greatly reduced. Moreover, it is expected that the grouting process will do much to eliminate infiltration.

Contractor's Plant—The plant at Shaft 1, by means of which the first section of tunnel is being constructed, includes two low-pressure compressors operated by two 50-hp. three-phase motors, operating at 900 r.p.m. Air is conveyed by 6-in. lines from the compressors to the receivers and then by an 8-in. line to the tunnel. In order to provide circulation in the tunnel, the air line has two outlets—one near the heading and the other just inside the lock. This arrangement results in a circulation of air as the pressure readjusts itself. The equipment also includes two high-pressure, electrically operated compressors for grouting and miscellaneous work. One of these compressors is almost constantly employed in grouting outside the tunnel lining to reduce air leaks. Owing to the location of the plant in close proximity to dwellings and apartments, it was deemed desirable to equip the compressors with Maxim silencers. These silencers have proved very satisfactory and practically all noise has been eliminated. The plant for Section 2 is located at Shaft 2 near the beginning of the 10-ft. section. The equipment is the same as on the first section.

Two locks were constructed on Section 1, the first being about 100 ft. south of the first shaft. About 500 ft. of tunnel was constructed from this lock, and then, owing to danger of air leakage on the shallower section, the contractor believed it desirable to build a second lock when the deeper section was reached. The remainder of Section 1, as well as Lock 3, was built using this second lock. Lock 3 is situated on the second, or 10-ft., section just south of the second shaft. Each lock consists of a completed section of tunnel carefully plastered and bulkheaded. The doors are 4½ ft. wide and 4ft. 8 in. high and are constructed of ¾-in. steel. A rubber gasket ½ in. thick permits the airtight closing of the doors. Each


Grout fill
13"Brick wall
Jacks
Shield in place
Needle beam
Former location of front end of needle beam
Seat
Canvas drop
6"x6"Timber breast work
Needle beam inserted in new monkey hole
Location of 6"x6"timber breast work after third operation
Grout fill
Temporary sump
(Third operation) is the removal of earth below line C-C. The moving ahead of 6"x6"breast work and laying of sheeting
Elevation B-B

SECOND OPERATION IN NEEDLE BEAM TUNNELING

door is provided with an 8-in. bullseye for the use of the lock operator and for emergencies.

Personnel—The sewer is being constructed by the Division of Engineering and Construction of the city of Cleveland, Robert Hoffman, chief engineer. It was designed under the direction of George B. Sowers, deputy commissioner of the division. Encell C. Richardson is engineer of sewer design and furnished the information herein relative to design. The construction is under the direction of S. H. Murdock, engineer of construction, and W. A. Cunningham, district engineer. The contractors are Winterbottom & Connelly, of Cleveland, and Al Connelly is in immediate charge of construction work in the field.

Commission Finds Failure of St. Francis Dam Due to Defective Foundations

Commission Appointed by Governor of California Declares Quality of Foundation Rock Poor—Initial Failure Occurred on or Near Fault in Right Bank—Concrete of Good Quality

THE COMMISSION of engineers appointed by the Governor of California to investigate the St. Francis dam disaster handed in its findings on March 27. Complete copies of the report with illustrations will be available later; meanwhile an advance typewritten copy of the text was supplied to *Engineering News-Record* through the courtesy of Edward Hyatt, state engineer, and has been abstracted in the following. Where the exact language of the commission is used, quotation marks are employed. The three conclusions of the commissions are given first and the more detailed findings follow.

"*Conclusions*—(1) Failure of the St. Francis dam was due to defective foundations.

(2) "There is nothing in the failure to indicate that the accepted theory of gravity dam design is in error or that there is any question about the safety of concrete dams designed in accordance with that theory when built upon even ordinarily sound bedrock. On the contrary, the action of the middle section, which remains standing even under such adverse conditions, is most convincing evidence of the stability of such structures when built upon firm and desirable bedrock.

(3) "The failure of this dam indicates the desirability of having all such structures erected and maintained under the supervision and control of state authorities. . . . This disaster emphasizes the fact that while the benefits accrue to the builders of such projects, the failures bring disaster to others who have no control over the design, construction and maintenance of the works. The police power of the state certainly ought to be extended to cover all structures impounding any considerable quantity of water."

Findings of the Commission

Water storage in St. Francis reservoir began in March, 1926, but in that year the maximum storage was only 13,200 acre-ft., as compared with the reservoir capacity of 38,100 acre-ft. In January, 1927, the reservoir was filled to within 3 ft. of the spillway level and was kept nearly full throughout 1927. It was practically full when the failure occurred.

Evidence showed little seepage through the structure of the main dam itself, but seepage through the foundation on which the dam rested appears to have increased to a maximum of between 1 and 2 sec.-ft. on the afternoon of the day preceding failure. The commission was unable to verify rumors of muddy seepage. Evidence indicated that there had been no alarming developments at the dam up to one hour prior to the failure, at which time a caretaker was seen on the structure.

The break came suddenly and released a flood that attained a maximum depth of 125 ft. at a point near the dam. An even greater depth is reported at Power House No. 2, 1½ miles below the dam. Velocity of the wave and time required for the peak to reach points in the valley below are given in the accompanying table.

"It seems probable that the flood peak immediately below the dam exceeded 500,000 sec.-ft. and this, together with its occurrence in the darkness and the suddenness and violence of the wave, was such that very few persons in the constricted valley below the dam escaped with their lives, although they were immediately adjacent to the safety of the steep slopes of the bordering hills. At a construction camp of the Southern California Edison Company, 16½ miles below the dam, more than 80 out of about 140 perished."

VELOCITY OF FLOOD WAVE BELOW ST. FRANCIS DAM

Location	Time of Arrival of Flood	Time of Travel From Preceding Location, Minutes	Distance in Miles From Preceding Location	Velocity in Miles Per Hour From Preceding Location
Borel power line at dam	11.58 p.m.			
City Power Plant No. 2	12:03 a.m.	5	1.5	18.0
So. Calif. Edison Co. substation near Saugus	12:38 a.m.	35	7.5	12.9
So. Calif. Edison Co. construction camp at Kemp	1:20 a.m.	42	7.5	10.7
Fillmore bridge	2:25 a.m.	65	12.7	11.7
Santa Paula	3:10 a.m.	45	8.5	11.3
Saticoy bridge	4:15 a.m.	65	6.8	6.3
Montalvo bridge	5:00 a.m.	45	4.0	5.3

Construction of the Dam—The following points were brought out in the review of construction methods. Foundation excavation was carried 8 ft. below the level of the diversion dam that was put down into tight material under the stream bed to exclude stream flow from the excavation, and the lowest concrete was poured at El. 1,630. On the left bank the excavation was notched into the rock along the natural inclined plane of the canyon wall without steps and with no cutoff wall. Beneath part of the foundation on the right bank a cutoff trench about 3 ft. wide and 3 ft. deep was used. Relief of uplift that might be caused by water pressure underneath the dam was provided for only in the bed of the stream. Here ten holes, variously reported to be from 15 to 30 ft. deep, were put down and pipes were led thence to a common outlet. The drainage from this system is said to have been very small. "Most of this drainage system is included under the portion of the dam which remains standing; this is probably merely a coin-

cidence." No inspection gallery was put in the dam nor was pressure grouting attempted under any part of the structure.

The concrete aggregate was pit-run sand and gravel from the stream below the dam; 1.12 bbl. of cement was used per cubic yard of concrete. Three representative concrete specimens taken from the wrecked dam and tested in the form of 6-in. cylinders in the laboratory showed compressive strengths ranging from 2,000 to 2,717 lb. per sq.in.

Dam Placed Astride of a Fault

Character of the Foundations—Regarding geological conditions, the commission finds that the dam was placed astride of a fault or contact between a reddish conglomerate and a fairly uniform mica schist. The schist is an ordinary variety of crystalline metamorphic rock consisting chiefly of quartz, white mica and probably some feldspar. It has pronounced fissility or cleavage and splits readily into thin plates; as a consequence it weathers and disintegrates into small flakes or scales. "In many places the schist has been strongly sheared, commonly along planes roughly parallel with the schistosity or planes of lamination. Along these shear zones the rock has been changed to an exceedingly fragile, flaky material that can be readily excavated with the pick. From a structural point of view such sheared schist is extremely weak material."

After drying out for a few days, the surface of the conglomerate on the right abutment "showed plain smooth surface when broken and some of the hardest specimens rang under the hammer. Many of these, however, go to pieces when immersed in water for a few hours, and samples taken over a considerable area have gone to pieces almost immediately upon immersion. Material from the gouge along the fault between the conglomerate and schist rapidly becomes soft and unctuous when immersed."

The contact between the conglomerate and schist on the right bank shows considerable ancient movement. The rush of water through the break at this point has scoured the foundation rock to a considerable depth. On the left bank the water carried away a large amount of the schist not only on the side of the canyon or along the abutment but also in the bottom. "Probably due to combined effect of water-soaking and undercutting a very large and conspicuous slide has developed on the hillside on approximately the line of the left-bank abutment."

Dip of Rock Responsible for Slides

The general strike of the schistosity is parallel with the course of the canyon at the dam site (N. 60 deg. to 70 deg. E.). The dip is northwesterly. Consequently the lamination of this schist is not far from parallel with the steep slope on the left bank. This slope in fact is conditioned in large part by the schist laminations, which are also partly responsible for the landslides. While schist is not a soluble rock nor is it ordinarily softened by wetting, it is weak with respect to stresses parallel to planes of lamination.

The conglomerate strikes N. 15 deg. W. and dips 46 deg. W. The pebbles, usually small and sparsely distributed, are embedded in a high proportion of fine-grained, sandy, micaceous, flaky detritus. Peculiarities of this formation observed at th dam are at least in part a consequence of the faulting between the conglomerate and schist, known as the San Francisquito fault.

No Earth Movement—This fault passes beneath the northwestern part of the dam site and has long been known, being represented as a "dead" fault on the map compiled by the Seismological Society of America. The present investigation shows that there has been no movement on this fault since the dam was built. The seismographs at the California Institute of Technology, Pasadena, recorded no earth tremors of even slight intensity at any time near the time of the dam failure and "there appears to be no reason to believe that faulting or other major earth movement was to any degree responsible for the failure of the dam."

The fault passes under the dam site with a strike about N. 51 deg. E., or approximately parallel to the canyon. The dip varies between 30 and 45 deg. to the northwest. On the schist side of the fault is a well-defined clay gouge, in places at least 8 in. thick, consisting chiefly of comminuted schist ground to clay by movement on the fault. When dry the gouge is fairly hard, but when wet it is an unctuous, plastic clay with some inclosed fragments of schist. Under the gouge, in some places for a width of 10 ft., the schist is crushed and sheared.

On the upper side of the slip-plane is a reddish gouge composed of ground-up conglomerate. This is generally thicker than the schist gouge and grades rather indefinitely into disturbed crushed conglomerate. "When dry this material is firm and coherent, but it becomes soft and plastic when wet. In places this reddish gouge is fully 4 ft. thick."

Conglomerate Rock Has Little Strength

Above the fault plane the conglomerate is traversed in various directions by intersecting fractures, some of which contain small seams of clay gouge and others are filled with gypsum. Pebbles in the conglomerate have in many instances been fractured, sheared and faulted. "Finally, the whole mass of the conglomerate has been so minutely crushed as to have lost most of the strength to be expected in a rock possessing its general appearance. When dry the rock is moderately hard and fragments of considerable size can be broken out and trimmed down with a hammer to specimen size.

"When, however, a piece of the rock is placed in water a startling change takes place. Absorption proceeds rapidly, air bubbles are given off, flakes and particles begin to fall from the sides of the immersed piece and the water becomes turbid with suspended clay, and usually in from fifteen minutes to an hour a piece the size of an orange has disintegrated into a deposit of loose sand and small fragments covered by muddy water. Whatever may have been the original cementing material of the conglomerate, its efficiency has been destroyed by crushing, aided possibly by solution, and the rock at present is held together merely by films of clay. It is possible that this part of the conglomerate as originally deposited contained considerable clay that never became lithified. Clearly, when thoroughly wet, the conglomerate at the northwestern abutment (right bank) of the dam ceased to have the characteristics commonly denoted by the term rock."

The mica schist on the opposite side of the canyon (left bank) shows separation planes along the schistosity, and landsliding is therefore always imminent and may be produced by any one of several causes. Above the dam site several marked recent slides have taken place. Careful examination of a large one near the dam showed no water line, erosion furrows or other evidences of the

action of the standing or moving water of the reservoir. "Evidently the sliding occurred after the withdrawal of the water from the reservoir. The added weight of the infiltrated water while the reservoir was full and the rapid removal of the water support when the dam failed are sufficient causes for the landslides above the dam." The sliding at the east abutment (left bank) of the dam "is evidently due to the removal of support as a result of the destruction of the dam and the undercutting of the slope by the waters released by the dam failure.

"It is concluded that all of the recent landslides in the vicinity of the dam site took place after and as a result of the failure of the dam and were in no way responsible for such failure."

Laboratory tests on a sample of the rock taken from the now exposed foundation of the dam showed the specific gravity to be 2.414. The compressive strength was 523 lb. per sq.in. (A.S.T.M. standards). The total porosity was 2.25 per cent, with the following results of absorption tests:

Total Time Elapsed	Per Cent Absorption By Weight
10 minutes	0.59
30 minutes	0.69
1 hour	0.73
2 hours	0.79
2 hours, 30 minutes	0.79

"In making the above tests rock was broken up into pieces passing a 1½-in. ring and placed in a bottle of water; each piece was carefully brushed to remove loose particles; the total sample weighed 503.6 grams dry. At the end of twenty minutes the samples had disintegrated in a very marked way and a layer of sand about ⅜ in. deep was formed on the bottom of the bottle."

Alignment of Midsection Checked

Midsection of Dam Moved—A recent survey shows that the top of the section that remained standing has moved 0.70 ft. from its original position, but it is as yet uncertain whether this movement is due to tilting, to horizontal displacement of the whole mass or to a combination of the two.

"The concrete in the dam is demonstrated by inspection, by tests and finally by the behavior of enormous blocks remaining from the wreck to have been of satisfactory quality and adequate strength. There can be no question that such a dam properly built upon a firm and unyielding foundation would be safe and permanent under all conceivable conditions, except perhaps faulting and earthquake shocks of tremendous violence. Indeed, such a dam may properly be deemed to be among the most durable of all man-made structures.

"Unfortunately in this case the foundation under the entire dam left very much to be desired. The material under the central and left end was a mica schist of thin and easily separable laminæ. The right end was founded upon a reddish conglomerate which, even when dry, was of decidedly inferior strength and which, when wet, became so soft that most of it lost almost all rock characteristics. Numerous samples taken from the present surface which had been eroded to a considerable depth below the original foundation and some samples from underneath the remaining wing wall on the right bank quickly softened and changed into either a mushy or a granular mass when immersed in water. Unfortunately this material is of such a nature that when entirely dry it is hard and rocklike in appearance and characteristics, although defective in compressive strength.

"With such a formation the ultimate failure of this dam was inevitable, unless water could have been kept from reaching the foundation. Inspection galleries, pressure grouting, drainage walls and deep cutoff walls are commonly used to prevent or remove percolation, but it is improbable that any or all of these devices would have been adequately effective, though they would have ameliorated the conditions and postponed final failure.

Initial Failure—"While as yet the manner and chronological order in which the failure of various sections of the structure occurred are not entirely certain, the present locations of the fragments from the right bank indicate this as the point of initial failure, which was quickly followed by progressive but rapid failure of the left end. Many of the available data indicate that the initial foundation failure occurred near or at the old fault or contact between the conglomerate and schist on the right bank and was due to percolation of water into and through this section of the foundation, with resultant softening of the conglomerate under the dam. Either a blowout under or a settling of the concrete at this place, or both, occurred, quickly followed by the collapse of larger sections of the dam.

"It is probable that the rush of water released by the failure at the right bank caused a heavy scour against the left canyon wall at the toe of the dam. This rapidly cut away the schist, including the material under the toe of the left end of the dam, and caused the failure of that part of the structure. The escaping water then continued to cut away the schist from the left bank until a maximum depth of about 30 ft. below the original foundation level was reached."

The report is the unanimous finding of the commission, which consists of the following: A. J. Wiley, chairman, consulting engineer; F. E. Bonner, district engineer, U. S. Forest Service, and California representative Federal Power Commission; F. H. Fowler, consulting engineer, H. T. Corey, consulting engineer; George D. Louderbach, geologist; F. L. Ransome, geologist.

Water-Borne Typhoid at St. Leonard, N. B.

Pollution of the water supply of St. Leonard, N. B., by typhoid sufferers in a family living on the catchment area is held responsible for a typhoid outbreak in the village which resulted in 200 cases and seven deaths. Typhoid in the family responsible for this epidemic is thought to have been caused by the temporary use of polluted water from the St. John River. According to information supplied to *Engineering News-Record* by Dr. George G. Melvin of Fredericton, N. B., chief medical officer for the Province of New Brunswick, the 200 cases of typhoid "occurred in very rapid succession—indeed, almost simultaneously." Preventive measures included the boiling of all drinking water; inoculation against typhoid of 600 to 800 persons, particularly children; sanitary control of the milk supply, including the stoppage of deliveries by dealers in whom or in whose families typhoid had developed, and the disinfection with chlorinated lime of all privies, "the town not being supplied with a regular system of sewerage." The epidemic was over in about six weeks. Three medical members of the provincial Department of Health took part in abating the epidemic, aided by four nurses, two supplied by the department and two by the Red Cross. Dr. Melvin's letter on this subject, written March 15, says: "Representations to the town authorities to install chlorination have been made by this office and I am hopeful that the same will be put into effect shortly."

Water Consumption and Sewage Discharge at Denver

A Study Based on Measurements for a Year of the Water Delivered to the City Mains and of Main Sewer Discharges

By S. T. Weller
Engineer, Board of Water Commissioners, Denver, Colo.

What Appears to be by far the most complete study of the relative amounts of water supplied to a city by its water-works and removed therefrom by its sewerage system is summarized in detail below. That the sewage flow of Denver is 95 per cent of the public water supply may not surprise many of the readers of the article so much as the conclusion that from the 762.5 miles of distributing pipe in the city there is a leakage loss of only 0.5 m.g.d., or less than 1 per cent of the water delivered to the mains. Less surprising, soil conditions and ground-water levels at Denver considered, is the conclusion that there is no "considerable amount of infiltration" into the sewers. The main reason for these notable studies at Denver was litigation by irrigation interests designed to compel the city to increase the volume of stored water sent down the river. The city has therefore made detailed studies of water consumption and of sewage flow, using recording gages for sewage depths and current meters for velocities. These and other elements of the study are detailed somewhat minutely in the article, which deserves the attention of both water and sewerage engineers. —Editor.

Continuous gaging of the main sanitary sewers of Denver, Colo., for the year ended Nov. 30, 1927, and comparison of the results obtained with the amount of water supplied to the city show that 95 per cent of the water used for domestic purposes is returned to the South Platte River through the sewerage system. Methods employed and data obtained are shown in this article, which is part of a report made for the Board of Water Commissioners, city and county of Denver.

A considerable part of the summer water supply of the city of Denver is drawn from its reservoirs, Lakes Cheesman, Antero and Marston. As a large part of this stored water reaches the river through the sanitary sewers of the city, the amount of water available for the use of the irrigation interests below Denver is materially increased from the reservoirs of the city. Realizing the immense value of this addition of water to the river during the summer months, these irrigation interests, through the employment of high-class legal and technical advisers, have resisted every attempt of the city to increase its use of direct rights, as the growth of the city demands, and in this way hope to compel the city to build additional reservoirs and use an ever-increasing percentage of stored water, thus furnishing an increasing amount of irrigation water each year at a great expense to the city and totally without cost to the irrigation interests. In connection with some of this litigation, it was found desirable to ascertain the exact amount of the domestic water supply that is returned to the river by way of the sanitary sewers and the relation existing between the water used in the city and that returned.

All water delivered to the city distribution system is measured by recording gages. Hourly readings of the elevation of each of the small reservoirs make it possible to ascertain the exact amount of water used in the city during any stated period of time. To obtain the information desired, it was found necessary to determine the amount of: (1) sewage being discharged; (2) water supplied by wells (both artesian and surface) and the possibility of this water entering the sanitary sewers; (3) ground water picked up by the sewers, if any; (4) storm water entering the sanitary mains. With these figures available, it is possible to determine how much of the city's domestic water supply is returned to the South Platte River during any period of time and to obtain a very close estimate of the amount of water used for lawn irrigation and street washing during the summer months; also any leakage that might exist in the distribution system would be indicated by an excessive amount of consumptive loss.

TABLE I—SIZES OF MAIN SEWER AND GRADES AT POINTS OF GAGING

	Diameter, In.	Material	Grade, Per Cent
Delgany St.	77	Brick	0.0489
South and West Side	70	Brick	0.0728
East Side	38	Brick	0.45
Berkeley	21	Tile	1.27

Sewage-Recording Gages—Recording gages were installed on the four sanitary trunk sewers as near their points of discharge as good gaging conditions made possible.

Gaging vaults and gage installations are practically identical, except as to the depth of the wells mentioned just below. In each case a vault 8x8 ft. in plan, inside dimensions, was constructed adjacent to the sewer with its roof flush with the street and its floor a few inches above the top of the sewer. Vaults are brick walled, with concrete floors and roofs. A 3x3-ft. well, lined with concrete and extending 6 in. below the sewer invert, is connected to the sewer by a 6-in. tile laid in concrete. On a shelf directly over the well and about 3 ft. above the vault floor is mounted a water-level recorder, equipped with a seven-day clock, allowing 1 in. horizontal travel for each 24 hours. The vertical scale is 1 to 2. This gives a continuous record of the depth of flow in the sewer, as the surface of water in the well is always the same as the surface of the flow. The zero point of the gage was set at the zero point of the sewer flow and frequently checked.

Velocity Determinations—The low point of flow for each 24-hour period is reached between 4 and 6 a.m. The flow continues at a low rate until about 8 a.m., when it rises rapidly, reaching a maximum about noon. There is then a gradual fall to the minimum point about 4 a.m. The minimum rate of flow averages about 65 per cent of the maximum rate of flow for the same day. During the period of low flow and until the following rise has reached a high point, probably near 90 per cent of the maximum, the flow is perfectly clear water. This condition makes possible the use of a current meter, with

accurate results, over almost the total average daily variation, so that very few readings on the gage have to be taken from a point on the discharge curve at any considerable distance either above or below the actual measured portion of the curve. Current-meter readings were made on each main at all available rates of flow. These readings were taken from 4 to 10 a.m. each day from Oct. 6 to 22, 1926, and at various hours on other dates. In the two smaller sewers at the lowest points of flow only one setting of the current meter was possible, but this was increased to three as soon as the area of the cross-section of the flow would permit. At no time was a measured velocity applied to a cross-sectional area of more than 0.25 sq.ft. In the larger sewers from five to twenty meter settings were possible, not more than ½ sq.ft. of area being allowed to each setting. The average velocity for each set of readings was obtained by taking the mean of the current-meter results. This average was checked by plotting vertical velocity curves with readings taken with the current meter held at various depths on vertical lines 1 ft. apart horizontally, proportioned to the area represented. The average velocity and discharge obtained by this method was in all cases found to be the same as by using the mean of the velocities, probably because of the regular size and grade of the sewer.

TABLE II—COMPUTED VALUES OF n

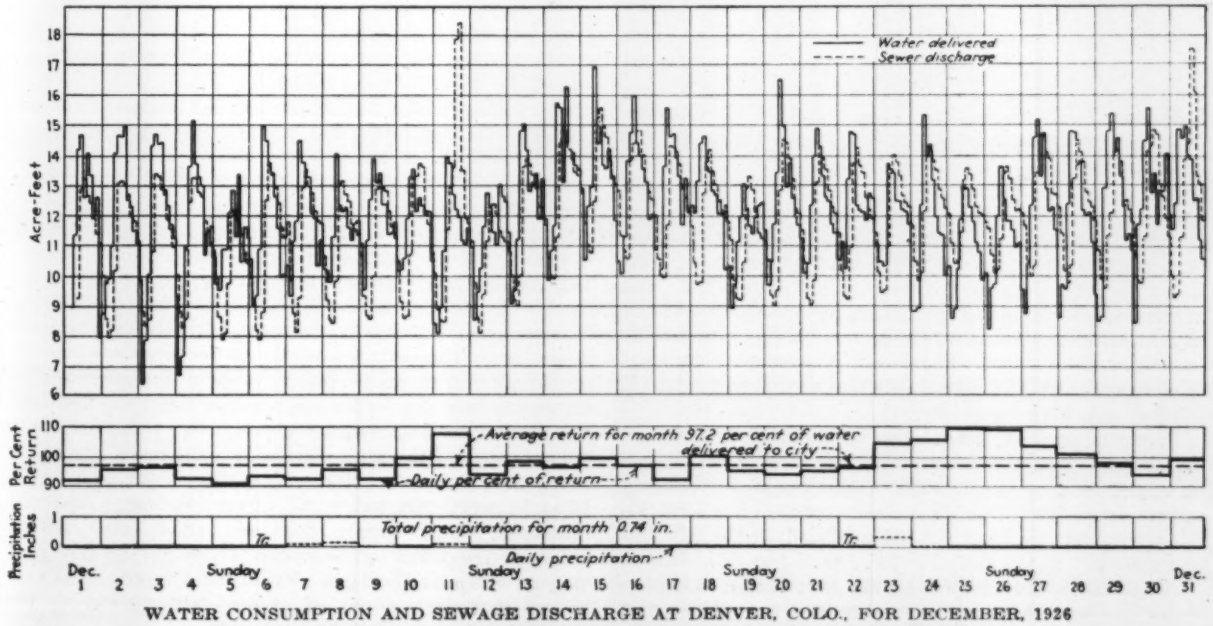
Sewer	High	Low	Average
Delgany St. (77 in.)	0.0134	0.0131	0.0133
South and West Side (70 in.)	0.0103	0.0102	0.0103
East Side (38 in.)	0.0136	0.0131	0.0133
Berkeley	0.0156	0.0152	0.0156

Current-meter ratings were made at the following depths of flow: Delgany sewer at many depths of flow from 2.16 to 3.08 ft.; South and West Side sewer, various depths from 1.20 to 1.53 ft.; East Side sewer, from 0.39 to 0.70 ft.; Berkeley sewer, 0.42 to 0.65 ft. The velocity as determined was then applied to the formula $V = C \div \sqrt{RS}$, R being the hydraulic radius of the section, S the slope in feet per thousand. Computed values of the coefficient of roughness, n, are given in Table II.

The velocity as shown by a regular curve, plotted from the formula just given, in which C is based on an accurate determination of n, as in this series of tests, is probably a more accurate value than could be obtained by any other method of velocity measurement. This method is not to be recommended unless a large number of current-meter readings are taken at a number of elevations of flow, and then only when the channel is regular in cross-section and not subject to change or silting up. In a sanitary main n probably decreases during the first few years of use, and then should remain constant for a long time, as there is no tendency toward a deposition of solid matter or incrustation that would reduce the velocity of flow.

Tables of the areas of cross-sections of flow for all depths and for each 0.01 ft. in depth were next prepared, and the velocity taken from the velocity curve was tabulated, the product giving the discharge of the main in second-feet for any gage reading.

Calculation of Discharge From Record Sheets—The record sheets used on the recording gages give a seven-day continuous record of the depth of flow in the sewer. Each horizontal division on the chart is ½ in. and represents two hours of time. To obtain the discharge for each day the average gage height for each two-hour period is read from the record sheet, and the average gage reading for the day obtained. The discharge corresponding to this average gage reading is then taken from the discharge tables already described. As a matter of record, a sheet is prepared each week showing the average reading of each gage for each two-hour period. The average gage reading for each day and the discharge in second-feet for the day are shown for each of the four sewers and the total combined discharge obtained. A monthly report is also prepared showing the discharge of each sanitary main each day, the total combined discharge for each day and the ratio of the discharge to



WATER CONSUMPTION AND SEWAGE DISCHARGE AT DENVER, COLO., FOR DECEMBER, 1926

The sewage discharge curve lags behind the water supply curve from two to four hours.

the domestic water supply used on that day, and monthly totals.

Well Water Used in City—About 65 buildings and factories in the city are equipped with artesian or surface wells and pumping plants. The production of each individual well was ascertained as closely as possible. The total amount of water used from wells during the years 1924, 1925 and 1926 is placed at 38.5 m.g. per month. and it is assumed that the return of this water through the sanitary sewers will be at the same rate as the water from the domestic supply. The district occupied by the stockyards and packing houses is just below the outlets of the sanitary sewers, and no portion of the water supply furnished that district can reach the city sewers, although it is probable that as large a percentage of it is returned to the river through private sewers as is returned through the sanitary sewers from the remainder of the domestic water supply. The average amount of water used in this district for the past three years has been shown by the meters to be 40 m.g. a month. The amounts above mentioned have, therefore, been considered as equal and no allowance has been made for a gain in supply due to the use of wells or for water used in the stockyards district.

Infiltration Water in Sanitary Sewers—The possibility of ground water entering the sanitary sewers by infiltration is the most difficult problem connected with the determination of the amount of the domestic water supply that is returned to the river by way of the sanitary sewers. The character of the ground in which most of the sewers are laid is such that it is impossible for ground water to exert any pressure on the outside of the sewers, and as Denver sanitary sewers are all of a high class of construction, it was not considered likely that any considerable amount of infiltration was possible.

To determine the amount of infiltration water in the sewers the actual amount of water consumed in the city was obtained for each two-hour period from 6 a.m. Dec. 1, 1926, to 8 a.m. May 1, 1927. These figures were taken from the recording gages on the conduits supplying the city with water and combined with the hourly readings of the reservoirs at the Capitol Hill pumping station and Ashland Ave. From the recording gages on the main sanitary sewers, the sewage discharge into the river was obtained for each two-hour period during the months of December, 1926, January, February and March, 1927. More than 30,000 gage readings went into these results. From these figures a graph was plotted showing that the average time elapsing between the drawing of water from the distribution system for domestic purposes and its later discharge from the sanitary sewers into the river is about two hours. This figure is very close to the time as calculated from the average measured velocity existing in the sewers and the measured distance from the center of the city to the outlets of the sewers. Therefore, in preparing comparative figures of water consumption and sewage discharge, a lag of two hours was allowed.

From a personal knowledge of weather conditions existing through the month of December, 1926, it can be stated that no storm water could reach the sanitary sewers from Dec. 1 to 22 inclusive, except on Dec. 11. Therefore, the time considered in this discussion is limited to Dec. 1 to 10, inclusive and Dec. 12 to 22 inclusive.

All water delivered through the distribution system is under pressure, so that large quantities are available at any time, as the pressure is maintained regardless of the rate of delivery. The discharge through the sewers is entirely a gravity flow in an open channel. Because of this condition of flow in the sewers, there is a tendency for the discharge to be at a more uniform rate than the rate at which water is drawn from the mains. This causes the discharge curve to smooth out many minor irregularities shown in the consumption curve.

The sewage discharge into the river by the sanitary sewers during the period under discussion was undoubtedly from one or at most two sources: (1) The main source, sewage from domestic water supply; (2) ground water entering the sewers by infiltration. Only the combined flow of the two can be measured.

Assuming that some ground water enters the sewers by means of infiltration, the amount of water so entering will be practically a constant quantity for any short period of time—that is, it will vary only with the change in the elevation of the ground water in the territory traversed by the sewers. Any change in ground-water level is very gradual and no change would show in hourly or daily readings during a three-week period such as is here considered. If any ground water was entering the sewers during this time, it was a constant quantity.

Assuming the sewer mains to be discharging a constant quantity of ground water, say C acre-ft. per hour, and further assuming the domestic sewage to be discharging into the sewers at the rate of x per cent of the consumption (the value of x will vary slightly from hour to hour or from day to day, but within very narrow limits, and can be considered as a constant for this purpose), it follows that for any given period of time the total discharge from the sanitary sewer mains is equal to C plus x per cent of the water drawn for domestic purposes. As C is a constant and x must be less than 100, the ratio of the sewer discharge to the water consumption must decrease as the consumption increases if such a quantity as C exists. The average daily range of the ratio of flow of the combined discharge of the sanitary sewers is from 48 to 90 sec.-ft. and the average daily range of the rate of use of water from the city distribution system is from 50 to 95 sec.-ft. The gage records show that this ratio of return, 95 per cent, is maintained uniformly throughout the 24 hours regardless of the rate of use of water.

If we assume that a flow of 5 sec.-ft. of the total discharge is infiltration water, there would have to be a difference of 5 per cent of return between the high and low points of discharge each day, and if the infiltration water is assumed to be 10 sec.-ft., a difference of percentage of 23 per cent would be necessary. From the figures compiled for the months of December, 1926, to March, 1927, it is clearly shown that no such conditions exist in the city sewer mains. The rise and fall of the flow of sewage is practically uniform with the drawing of water from the mains, and the difference between the maximum and minimum points of the water consumption curve are very nearly the same as the difference between the maximum and minimum points on the sewer discharge curve of the same day. The gage records actually show an average variation of less than 1 per cent. The ratio between the measured sewer discharge and the measured water supply does not show any change, although the water consumption from day to day may vary as much as 12 m.g.d. From these figures it is safe to say that the amount of ground water entering the sewers is so small as to be negligible.

It is, therefore, conclusively shown that the discharge of the main sanitary sewers of Denver into the South Platte River is a measure of the return of the domestic water supply of the city and that such return is accomplished in the average time of about two hours following the drawing of the water from the city's distribution system.

Storm Water in the Sanitary Sewers—Certain portions of the city are not at present supplied with storm sewers, and some connections with street drains exist. On the East Side sanitary sewer a 20-in. storm sewer connects at Seventeenth Ave. and Colorado Boulevard, and on the Delgany St. sewer a number of small connections bring in the street drainage from a part of the territory included between Fifteenth St. and 26th St., and Lawrence St. and Wynkoop St. There are no storm sewer connections on the South and West Side sewer or on the Berkeley sewer. Long periods without precipitation are necessary for an accurate measurement of the return of domestic water supply, and the percentages then determined can be applied to the figures of water supply during periods when the precipitation is large. The first three weeks of December, 1926, were good for purposes of measurement, and the accuracy of the measurements is well indicated by the uniform percentage of return through varying conditions of water used, there being no noticeable differences in the percentage of return, whereas the rate of supply increased or decreased 25 per cent, or as much as 12 m.g.d.

TABLE III—WATER CONSUMPTION AND SEWAGE DISCHARGE DEC. 1, 1926, TO FEB. 12, 1927

Total amount of water drawn from the city distribution system, acre-ft.	8,863.54
Total discharge of the sanitary sewer mains, acre-ft.	8,466.82
Percentage of water returned to the South Platte River through the sanitary mains, per cent	95
Average daily use of water, acre-ft.	147.72
Average daily discharge from sanitary sewer mains, acre-ft.	141.11
Changed into figures of continuous flow, the above represents:	
Water used, sec.-ft.	73.86
Water discharged through the sanitary sewer mains, sec.-ft.	70.56

Actual Return of Domestic Water Supply—A study of the water consumption and of sewer discharge figures and the chart plotted therefrom shows a surprisingly regular action and reaction for each 24-hour period. Because of local conditions of use and varying location of demand, no two days will be found identical, but none is far from the average. The greatest variance occurs when the peak consumption is maintained over a period of six to eight hours and the minimum consumption reaches an extremely low point during the same 24 hours. Dec. 1, 2 and 3, 1926, show these characteristics although the average return for those days does not differ from that for the remainder of the month.

The average daily return for the entire month of December, 1926, was 97.2 per cent of the water consumption. Eliminating the days when it was possible that some storm water reached the sewers, the average was 95.2 per cent of the water consumption. On no day did the return vary as much as 5 per cent from this average. This average return, about 95 per cent, is the same as that obtained during the month of November, 1926, when the records were complete for fourteen of the 30 days of the month. The same average return of 95 per cent is maintained during the periods of no precipitation during January, 1927, and up to Feb. 13, 1927.

The Monthly Meteorological Summary issued by the Weather Bureau shows the months of January and February, 1927, to have been unusually dry, whereas in March, 1927, the precipitation was 229 per cent of normal. The great excess of temperature in February combined with the very light precipitation caused a large use of water for lawn irrigation during the latter half of the month. On Feb. 13 an article was published in the daily newspapers advising the thorough irrigation of lawns and trees, and on that date and continuing for the remainder of the month a decided increase in the amount of water drawn was noticeable. No corresponding increase was noted in the sanitary sewer discharge, so the percentage of return was lowered during that time, although the actual amount of return flow was unchanged. During March, 1927, there were periods of continuous precipitation covering several days at a time, and between these periods fairly warm dry days when considerable water was used for irrigation, so that the records for the month of March cannot be taken as showing the true amount of water used for strictly domestic purposes.

From Dec. 1, 1926, to Feb. 12, 1927, there were 60 days during which there was no possibility of any storm water entering the sanitary sewer mains, and the entire discharge from the sanitary sewers was from domestic water. Data for these days are given in Table III.

Disregarding the nature of the use of water drawn from the distribution system and the water entering the sanitary mains from storm sewer connections, Table IV shows the total water drawn from the city distribution system and the total discharge of the sanitary sewers from Dec. 1, 1926, to Nov. 30, 1927.

After careful examination of these data and investigations of the sources of data other than those obtained personally, it is my belief that the actual return of water, used for strictly domestic and factory purposes in the city, to the South Platte River by way of the sanitary sewer mains of the city is about 95 per cent.

The amount of storm water entering the sewers is so small a percentage of the total sewage carried that final estimates of the water used for lawn irrigation and domestic purposes are changed not more than 1 per cent by its omission. From Dec. 1, 1926, to Nov. 30, 1927, the total water delivered to the city distribution system was 67,987.84 acre-ft. The total discharge of the sanitary mains during the same period was 51,788.70 acre-ft. If the sewer discharge is taken as 95 per cent of the water drawn for domestic uses, the total drawn for domestic uses was 54,514.00 acre-ft., or 80.2 per cent of the total water used, indicating that 13,473.84

TABLE IV—WATER CONSUMPTION AND SEWAGE DISCHARGE AT DENVER, COLO., FOR YEAR ENDED NOV. 30, 1927

All Quantities in Acre-Feet

	Total Water Used	Total Discharge of Sanitary Sewers to River	Per Cent of Water Used Returned to River	Average Daily Use of Water	Average Daily Discharge of Sanitary Sewers
1926					
December	4,509.78	4,386.31	97.2	145.47	141.46
1927					
January	4,533.84	4,390.46	96.8	146.24	141.54
February	4,264.88	3,902.23	91.5	152.32	139.35
March	4,639.42	4,330.04	93.3	149.66	139.78
April	5,116.70	4,211.66	82.3	170.56	140.38
May	7,622.70	4,406.96	57.8	245.90	142.16
June	6,556.58	4,502.96	68.7	218.56	150.00
July	7,915.02	4,421.92	57.1	255.32	145.86
August	5,809.86	4,586.14	78.9	187.42	147.94
September	6,754.06	4,113.64	62.6	225.14	137.12
October	5,546.92	4,247.30	76.6	178.94	137.02
November	4,718.08	4,289.08	90.9	157.26	142.97
Total	67,987.84	51,788.70	76.2	186.1	141.9

acre-ft. of water was required for the irrigation of lawns and street sprinkling. As there are approximately 4,000 acres of lawn and more than 1,100 miles of streets in the city, this figure appears reasonable.

With the completion of the year's records to Dec. 1, 1927, the amount of water used for other than domestic purposes is found to be about 19.8 per cent of the total water used for the year.

Loss From Leakage in Water Distribution—The foregoing figures show the consumptive loss of water used for domestic purposes to be 5 per cent of the total water so used. At the present rate of supply this means a loss of about 2.5 m.g.d. This must include all loss from evaporation from the water used in household uses, in all steam and hot water plants, use in railway locomotives, for automobile washing and cooling and all other incidental losses. It is not possible to obtain any direct figures on these various uses, but it does not seem reasonable that the loss from leakage could make up a very large part of the total loss.

I have personally seen many miles of water mains uncovered after they had been in use for five to 25 years or more and have never seen a leak of any consequence unless the leak was noticeable on the surface and the pipe uncovered for the purpose of repairing it. From this personal experience and from the figures obtained in the preceding paragraphs, I do not believe the loss from leakage in the city's distribution system to be as much as 1 per cent of the water delivered for domestic use at the present time, or less than 0.5 m.g.d. The greater part of this leakage is probably from the several old wood-stave conduits still in use between Wynetka Junction and the city, the loss in the cast-iron pipes in the city streets being negligible.

The distributing system of the city of Denver consists of 762.508 miles of pipe of various sizes classified as shown in the accompanying table.

CLASSIFICATION OF PIPE IN WATER-DISTRIBUTING SYSTEM OF DENVER

	Miles	Inch-Miles		Miles	Inch-Miles
Galvanized iron	89.919	196.967	Concrete	6.215	410.052
Wood	38.368	1,496.630	Cast iron	622.547	5,277.260
Steel	5.459	204.676			
Total				762.508	7,585.585

Assuming the figure of 0.5 m.g.d. to be approximately the loss from leakage in this system, it indicates a loss of 656 gal. per mile of pipe per day, or a loss of 66 gal. per day per inch-mile of pipe throughout the entire system.

In many cities that are entirely metered it has been found that the total water used, as registered by many thousands of small meters, was from 15 to 40 per cent less than the amount delivered to the various distribution systems and measured through a few large meters at practically a continuous rate of flow. This difference has been called by various names, "water unaccounted for" being the most commonly used, and has been considered as largely leakage from the mains. This assumption of leakage is entirely unwarranted, and probably untrue, as the percentages of unaccounted-for water mentioned above are no greater than the errors known to exist in the large number of service meters used, which deliver water at varying rates and under varying conditions. Estimates of leakage in the distribution systems, based on such data, are entirely without value and extremely misleading.

Outlook for Production of Timber Railway Ties

WITH THE INCREASING USE of preservative processes for wood ties, the increased variety of species made available by such treatment and the resultant great increase in life of ties, the problem of a future supply of timber for ties has become of much less importance than heretofore. This change in a situation, which at one time threatened to be serious, was explained at a recent meeting of the American Forestry Association by E. E. Pershall, vice-president of the T. J. Tie Company. An abstract of his paper is given below. —EDITOR.

ANNUAL requirements of ties for our steam railroads and electric lines approximate 110,000,000 ties per year, equivalent to 4,000,000,000 ft. board measure, or one-tenth of the total annual cut of sawed lumber. The sizes, kinds and qualifications of first-class ties have been developed through years of watchful comparisons of ties in service, and the features of an acceptable tie are clearly defined in the specifications of the American Railway Engineering Association and the American Standards Committee, the latter representing the larger producers and consumers of ties. We have a truly national specification recognized by practically all of our first-class railways and tie producers. This uniformity in specifications has been an essential step in the elimination of waste and provides an established basis for valuing ties.

Timber suitable for tie production rarely consists of very large trees, as the larger trees are generally more valuable for high-grade lumber and curiously enough it costs more to make ties from the larger trees than from the smaller ones. The most desired diameters at the stump are from 12 to 20 in. This leaves trees standing in the woods measuring 10 in. and down at the stump, and within an average of fifteen years rotation on oak and seven years on Southern pine (not longleaf) another crop of ties can be expected from the usual and commonplace tie timber. Reforestation is not a difficult problem for tie timber, as the relatively small diameters of trees required make reforestation easier.

It would be impracticable to supply our needs in naturally decay-resisting timbers. However, many species that would have very short lives if the ties were untreated are now used after preservative treatment. This is conservation through preservation and is the largest single factor guaranteeing this country a supply of ties that will eventually have a track renewal rotation of twenty years, as against a period of from seven to fifteen years to grow another crop of trees.

In addition to the use of a wider range of species, there is an increase in the forest area from which we can economically haul ties, due to the development of good roads. This good road building has increased the production of ties along the rights-of-way of many railroads to a surprising extent. One railroad alone has increased its right-of-way production from 37,000 ties in 1918 to 145,000 in 1926. Besides diversification of species enlarging our supply of tie timber, together with preservation against decay, we are also making progress against mechanical wear. Ties are now being bored for spikes and adzed to give a uniform base for the rail or tie plate.

Leaders in the tie-producing industry are not so much concerned about a diminishing supply of good ties as they are about a decreased demand due to progress that has been made toward increased life of the ties in the track.

News of the Week

Current Events in the Civil Engineering and Contracting Fields

Merger Plan for Three Railways in Southwest Chain

The Missouri-Kansas-Texas Railroad to Be Trunk of a New System Proposed by Loree

A MODIFIED proposal for the consolidation of the Missouri-Kansas-Texas Railroad, the Kansas City Southern Railway and the St. Louis Southwestern Railway into one system was filed with the Interstate Commerce Commission on March 27. In May of last year the Interstate Commerce Commission disapproved a proposal to make a 5,800-mile system out of these three railroads, on the ground that the plan did not make proper provision for the protection of the rights of minority stockholders and also because it placed control of two large railroad companies in the hands of a small company with too little direct financial interest in the controlled companies. That plan made the Kansas City Southern Railway Company the dominating company.

The present proposal makes the Missouri - Kansas - Texas Railroad, a 3,200-mile line, the dominating company. The latter company proposes to acquire control of the St. Louis & Southwestern by purchase of preferred and common stock now held by the Kansas City Southern, and the remainder of the preferred stock by exchanging share for share its own preferred stock plus $5 in cash. It proposes to acquire the remaining common stock by an exchange for its own common stock. The company also proposes to acquire control of the Kansas City Southern by an exchange of preferred and common stock or by exchange of preferred and purchase of common stock of the Kansas City Southern. Stock of the Missouri-Kansas-Texas Railway now held by the Kansas City Southern is to be liquidated as market conditions permit, or by granting subscription rights or by trusteeing for sale all or part of it.

The applicant company proposes to buy for cash the stock of the St. Louis & Southwestern now held by the Kansas City Southern.

Additional Employees for Power Work Favored

The committee of the House of Representatives on interstate and foreign commerce has agreed to report favorably the Burton bill "authorizing additional employees for the Federal Power Commission." Under the provision of the bill, the commission requests the President of the United States to detail officers from the Corps of Engineers or other branches of the Army. It also specifies that persons under the Departments of War, Interior and Agriculture who are engaged in duties which are conferred upon the commission by the federal water-power act may be transferred to the commission.

Personnel of Committees on St. Francis Dam Investigations

Immediately following the collapse of the St. Francis dam of the Los Angeles water-supply system on the night of March 12, a number of investigating committees were appointed by the various interests affected. Only one of these committees, the one appointed by Governor Young, has reported. Its report is abstracted on p. 553.

Following is listed the personnel of each of the committees investigating the disaster. The preponderance of engineers, contractors and geologists is noteworthy.

Appointed by Gov. C. C. Young:

A. J. Wiley, chairman, consulting engineer; F. E. Bonner, engineer, U. S. Forest Service; F. H. Fowler, consulting engineer; H. T. Corey, consulting engineer; George D. Louderbach, geologist (U. C.); F. L. Ransome, geologist (Calif. Tech.).

Appointed by Los Angeles County District Attorney:

Ed. L. Mayberry, chairman, consulting engineer; Col. C. T. Leeds, consulting engineer; Walter Gordon Clark, consulting engineer; Allen E. Sedgwick, professor of geology, Univ. So. Calif.; L. Z. Johnson, geologist.

Appointed by Los Angeles City Council:

Dr. Elwood Mead, chairman, Bureau of Reclamation; Louis C. Hill, consulting engineer; Lansing H. Beach, consulting engineer; D. C. Henny (advisory capacity), consulting engineer.

Appointed by Los Angeles Bureau of Water Works and Supply:

D. W. Murphy, chairman, consulting engineer and geologist; Robert T. Hill, formerly professor of geology (U. C., Southern Branch, in L. A.); C. F. Tolman, professor of geology, Stanford University.

Representing California Industrial Accident Commission:

A. C. Wagner, construction engineer, Calif. Ind. Accident Comm.; J. Wesley Gebb, mining engineer, Calif. Ind. Accident Comm.

Appointed by Ventura County Supervisors:

C. E. Grunsky, consulting engineer; E. L. Grunsky, consulting engineer; (also geologist to be selected by Grunsky company).

Coroner's Jury:

Oliver Bowen, building contractor; C. D. Walz, mechanical engineer; H. G. Holabird, real estate; Capt. Blaine Noice, structural engineer; I. C. Harris, construction engineer; Sterling C. Lines, financial broker; W. H. Eaton, Jr., building contractor; Z. N. Nelson, construction engineer; Ralph Ware, contractor.

Flood Bill Passed by Senate Based on Chief Of Engineers' Report

Work to Be Directed by Board of Five—Entire Cost to be Paid by Federal Government

AN APPROPRIATION of $325,000,000 for flood control of the Mississippi River and its tributaries is provided under the Jones bill, passed by the Senate on March 28.

The planning of the work is left to a board composed of the Secretary of War, the Chief of Engineers, the president of the Mississippi River Commission and two civil engineers to be appointed by the President with the consent of the Senate. The bill now goes to the House for action. The Jones bill provides for flood control in the Mississippi Valley from the Head of Passes to Cape Girardeau, Mo., in accordance with the engineering plan recommended by the Chief of Engineers. It also provides that the entire cost be paid by the federal government, stating that "No additional local contributions to the projects herein adopted are required." All property damages, rights-of-way and floodways are to be paid for by the United States under the provisions of the bill. No such provision was included in the Chief of Engineers' plan, which was estimated to cost $296,400,000. The board of five members is directed to consider the engineering differences between the adopted project and that recommended by the Mississippi River Commission and "after such study its decision upon all matters considered by it shall be followed in carrying out the project," subject to the approval of Congress. Meanwhile $5,000,000 is provided as an emergency fund for repair or maintenance of flood-control works.

Other Provisions

Among other things provided by the bill is that surveys shall be made between Baton Rouge, La., and Cape Girardeau, Mo., and further approval of Congress secured before any flood-control work other than levees and revetments are undertaken on that portion of the river; and that no money shall be appropriated until local interests have given assurances satisfactory to the Secretary of War that they will maintain all flood-control works after their completion except controlling and regulating spillway structures. The bill further provides that projects for flood control of all tributary streams of the Mississippi River system be submitted to Congress at the earliest practicable date with the conclusions and recom-

mendations of the board of five members.

The actual work on the plan proposed by the bill is to be done by the forces of the Mississippi River Commission under the direction of the Secretary of War and under the supervision of the Chief of Engineers.

Everglades ad Valorem Tax Held Constitutional

By unanimous decision the Florida Supreme Court on March 26 decided in favor of the legality of the new Everglades Drainage District bonds issued last year and confirmed the constitutionality of the new legislative acts of 1927 which authorized the issuance of these bonds. In those acts it was provided that the district might assess an *ad valorem* tax against lands benefited, within the district, besides the existing acreage tax. This measure and the issue of bonds based thereon were later attacked on several grounds by owners of land near Miami. It was claimed that certain lands within the district would not be benefited by the drainage of the Everglades, that the proposed law involved double taxation and that the measure implied a guarantee for payment by the state of the drainage bond obligations. All of these points were denied in the decision of the highest court, after a lower court upheld the claims of those who protested against the bonds.

The supreme court holds that the bonds are obligations of the district and not of the state. It confirms the view that under the state Constitution the state may not, directly or indirectly or contingently, be obligated to pay in whole or in part the principal or interest of the district bonds. The laws authorizing the issuance of the new bonds, however, do not loan the credit of the state to the district. The *ad valorem* tax does not constitute double taxation nor is it an unlawful delegation of the taxing power. Lands may be less or more benefited by the drainage, depending upon their contiguity to the drained territory, but nevertheless they may justly be required to bear the proportion of a reasonable special tax burden if the object sought is a common benefit.

Illinois Water Works Men Discuss Wells and Hard Water

Logically the program of the Illinois Section of the American Water Works Association meeting March 29 and 30 at Urbana was devoted largely to well water and softening, since the bulk of the supplies in that state are wells and the water is hard. More than 100 were registered.

The principal business was a resolution calling on the parent organization to waive the $5 entrance fee, which those who have been most active in soliciting new members find is a decided handicap in getting the small town operator signed up.

Paul Hansen conducted a round-table discussion on chapters of the *Manual* on ground water, purification and services. This is in line with a request to each section from the national association. H. F. Ferguson and one of his assistants, C. W. Klassen, outlined experiences of the state Board of Health with contamination of wells and reservoirs. "Economics of the Mississippi Flood-Control Situation" was the subject of an illustrated address by W. W. De Berard, associate editor, *Engineering News-Record*. Other speakers were H. H. Gerstein and Dr. A. M. Buswell.

Newly elected officers for the ensuing year are as follows: Chairman, C. R. Roos; vice-chairman, A. E. Gorman; treasurer, H. E. Keeler; trustee for three years, John R. Baylis.

Am.Soc.C.E. Spring Meeting in Washington, D. C.

The spring meeting of the American Society of Civil Engineers will be held in Washington, D. C., April 25-27. The executive meeting will be preceded on April 24 by a students' conference, at which the principal speaker will be Robert Ridgway, chief engineer, Board of Transportation, New York City. The technical program will open on Wednesday morning, April 25. The first day will be given over to work of the government departments and inspection of the Bureau of Standards. The second day will be devoted entirely to the sessions of the technical divisions. On the third day an all-day excursion has been arranged to Camp Humphreys, Va., where all the equipment of engineer troops will be inspected and its use demonstrated. To the many ordinary attractions of Washington in the spring have been added an unusual number of special entertainments for the ladies.

Queens Borough President Resigns With Charges Pending

Maurice P. Connolly, President of Queens Borough, New York City, sent his resignation to Mayor Walker on April 3, six days before the date set for public hearings on a petition to Governor Smith for his removal on account of alleged irregularities in connection with sewer construction contracts. The charges were filed months ago and proceedings under them soon started, as noted in *Engineering News-Record*, Dec. 22 and 29, 1927, pp. 1021 and 1028, and Jan. 5, 1928, p. 35. Court decisions based on legal technicalities without bearing on the charges, together with disappearance of records and witnesses needed in the preparation for the required public hearings, have caused repeated delays and have necessitated emergency state legislation, the last of which was an act requiring the appearance of witnesses under penalty of $100,000 fine. Most of the desired witnesses who had not already appeared submitted themselves for preliminary examination by April 2. On that date the Board of Estimate and Apportionment of New York City formally declined to provide the accused Borough President the defense fund of $100,000 which he had requested, whereupon Mr. Connolly announced that he would resign. This he did on April 3.

A notable array of lawyers and engineers have been at work for months on both sides of the case. If the resignation is accepted and the removal proceedings are thus ended, it is assumed that the substance of the charges will be laid before a grand jury.

State of Vermont to Investigate Flood Control

On March 28 there was organized in Vermont an Advisory Committee of Engineers on Flood Control, appointed under direction of the Governor by the Public Service Commission. The members of the committee are Prof. J. W. Votey, dean of the engineering department of the University of Vermont (Burlington), chairman; Prof. H. K. Barrows, of Boston, who will act as consulting engineer for the committee; and Harry Barker, consulting engineer, of New York, secretary.

This committee is planning to make a thorough study of the rivers of the state from the point of view of flood control and submit its findings in a report to the state Legislature of 1929. The necessary river and reservoir site surveys to supplement existing data will be made in co-operation with the topographic branch of the U. S. Geological Survey. About twenty river gaging stations will also be established at once, in co-operation with the water resources branch of the Geological Survey, and will be maintained to provide the necessary data for future projects.

This investigation is being financed by the state in co-operation with the public utility companies. Besides furnishing information upon storage reservoirs for power use and flood control, it is expected that the resulting report will serve as a basis for the consideration of enabling legislation on those subjects.

Drainage and Flood Relief Bonds for New Orleans

Of four amendments to the state Constitution of Louisiana up for ratification on April 17, one would authorize the New Orleans Water and Sewerage Board to issue $9,000,000 of bonds for drainage, sewerage and water-works extensions—drainage apparently being the prime object. This amendment would also enable the city to issue additional bonds, under the restriction noted below, without getting a favorable state-wide vote on a constitutional amendment, as now required. Four of the five restrictions on additional bond issues, just mentioned, are: They must be approved by three-fourths of the members of the sewerage and water board, two-thirds of the members of the city council, three-fourths of the members of the

board of liquidation of the city debt and by a majority both in number and in amount of the property tax payers of the city. The fifth restriction is that all the outstanding bonds of the sewerage and water board shall not exceed 5 per cent of the assessed valuation of the city.

Of the three other constitutional amendments noted, one would authorize the New Orleans Levee Board to issue bonds to reimburse land owners and residents for losses resulting from cutting the Caernarvon levee last year to prevent the flooding of New Orleans. Another authorizes postponement of taxes in areas flooded by the high water of 1927 and also authorizes parishes so afflicted to raise money for current needs. The fourth amendment would authorize the State of Louisiana to donate 400 acres of land in Rapide Parish (old Camp Stafford) to the United States as a site for a veterans' hospital.

All four amendments are approved in a circular signed by Arthur M. Shaw, a consulting engineer of New Orleans, as chairman of the drainage committee of the New Orleans Association of Commerce. The circular states that with $6,000,000 of expected surplus revenues within the next three years the $9,000,000 bond issue would enable the sewerage and water board to expend $15,000,000 for much needed water, sewer and drainage extensions.

Set-Back Buildings Now Permitted in Boston

An important change was recently made in the building laws of Boston, Mass., with the signing by Governor Fuller of a bill permitting the erection of so-called terraced buildings above the heretofore maximum height of 155 ft. The measure places a building limitation on volume rather than on height. The law, at the present time, has particular reference to the construction of the proposed New England Building which will be 28 stories in height. Although not high as standards are measured in other cities, this building will be more than twice as high as commercial buildings have been built in Boston. It will cover a plot 270 ft. wide by 450 ft. long and have a gross floor area of about 1,600,000 sq.ft.

New Cincinnati Union Terminal Authorized by I.C.C.

The Cincinnati Union Terminal Company received authority to construct the proposed union passenger station and equipment terminal at Cincinnati from the Interstate Commerce Commission in an order dated March 17, 1928. The total cost of the project is estimated at $31,500,000. The station will face Lincoln Park, but no definite plans for the type of building to be erected have yet been made. The terminal yards and facilities will be located in Mill Creek Valley, immediately west of the station, and will be of sufficient capacity to accommodate all of the passenger trains now entering Cincinnati, with allowance of space for an increase of 100 per cent in number of locomotives and 50 per cent in number of coaches.

The Cincinnati Union Terminal Company was organized by the following seven railroad companies: Baltimore & Ohio; Chesapeake & Ohio; Cincinnati, New Orleans & Texas Pacific; Cleveland, Cincinnati, Chicago & St. Louis; Louisville & Nashville; Norfolk & Western; and the Pennsylvania.

To Increase Convict Labor on Highway Work

Michigan is planning to double its force of convicts employed on highway work during 1928. The force, which will begin work about April 1, weather permitting, will number about 1,250 men, as compared with about 600 in 1927. To accommodate the increased prison force three new road camps will be established. According to the commissioner of pardons and paroles, the increase in convict labor is atttributable to the good results of last year. Part of the success with convict labor lies in the fact that the entire duty of guarding was placed with prison authorities and the direction of work was left entirely in the hands of the highway department. For 1928 a wage scale has been established as an incentive for willing work. The prisoners will be paid 5c. to 10c. an hour instead of the flat $1 a day scale formerly used.

Hoover Appointed to Engineering Foundation Committee

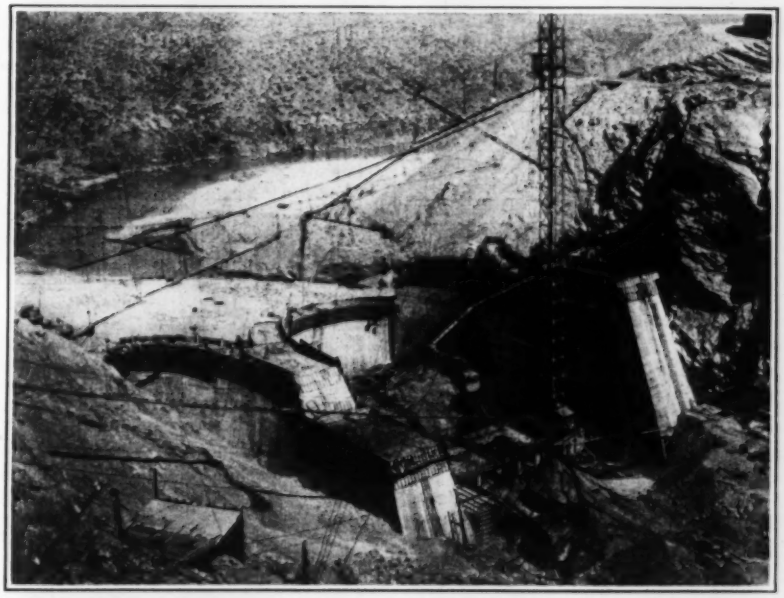
Engineering Foundation announces that at the meeting of the board of trustees of the United Engineering Societies on March 22, 1928, Herbert Hoover was appointed a member of the endowment committee for the Engineering Foundation and Engineering Societies Library and its executive subcommittee. He has accepted the appointment.

The endowment committee seeks to increase the foundation endowment to $5,000,000 to permit the society to meet the ever-increasing demands of service. The committee is also seeking a $2,000,000 endowment for the Engineering Societies Library, one of the largest technical libraries in the world. The present appropriation is inadequate to carry on the work.

Waterworks Conference to Be Held in Iowa City

A waterworks conference will be held in Iowa City, Iowa, April 11-14, under the joint auspices of the College of Engineering and the Extension Division of the University of Iowa, with the state Department of Health co-operating. The program will include papers and discussion on municipal water-supply problems, relation of water supply to public health, methods of measuring water, quality of water from different sources and treatment of municipal water supplies.

RAPID PROGRESS BEING MADE ON COOLIDGE DAM



Progress being made on the construction of Coolidge Dam on the Gila River in Arizona is shown in the above picture. Contract for the work was let in December, 1926, to Atkinson-Spicer Co. of Los Angeles. The dam is to be of "multiple dome" type, consisting of three domes 180 ft. center to center and two great buttresses. Total height is to be 250 ft. The dam was designed by Major C. R. Olberg, assistant chief engineer, Irrigation Bureau, U. S. Indian Service. F. A. Noetzli and L. C. Hill of Los Angeles are acting as consulting engineers on design and construction.

Five-Year Co-operative Railway Course Offered at M.I.T.

The Massachusetts Institute of Technology and the Boston & Maine Railroad have established a five-year co-operative course in railroad operation, the purpose of which is to provide (1) fundamental training in engineering at the Institute and (2) practical operating experience in the various departments of the railroad. Men who are accepted for this course will receive a training which aims to develop them for responsible positions in the transportation, motive power, and engineering departments. Students completing the course will receive both a Bachelor's and a Master's degree.

Besides fundamental subjects which are essential to the understanding of the civil, mechanical and electrical engineering problems in railroad operation, emphasis will be placed on the operation, extension and improvement of existing lines rather than on the construction of new lines; on economical operation of freight and passenger transportation; on the use of modern methods and equipment; and on auxiliary means of transportation.

Alternate periods in railroad employment and at the Institute are set up at the end of the second year of undergraduate work. While in the employ of the railroad students will receive wages of approximately 35c., 40c., 45c. and 50c. per hour during the respective work periods.

A committee on the co-operative course will be maintained at the railroad, and the Institute will appoint an administrative chief and a liaison officer, both of professorial rank, to cooperate with the railroad committee and also to supervise class instruction carried on while the students are at the railroad. The course is now in operation, and additional information on it can be secured from Prof. J. B. Babcock, Room 1-337, M.I.T., Cambridge, Mass.

Erection Started on Arlington Bridge Superstructure

On March 17 the first set of centers for one of the arches of the Arlington memorial bridge across the Potomac River, Washington, D. C., was put in place. The arches of the bridge are 94 ft. wide, face to face of the bridge, and will be constructed in four longitudinal sections of approximately equal weight. The two center sections of the four arches on the Washington side of the river will be constructed first, beginning with the section on the upstream side of the bridge center line. Construction of the downstream center section and of the two outside sections will follow in succession. It is estimated that the present season will be required for the construction of the four arches on the Washington side of the river, and the construction of the remaining four arches of the bridge can then be completed in 1929.

Washington Notes

Flood-Control Bill, Passed by Senate, Expected to Be Amended in the House—Muscle Shoals Up Again

By Paul Wooton
Washington Correspondent

GENERAL surprise was caused when the Senate, after an hour's debate on March 28, passed the Jones flood-control bill by a vote of 70 to 0. The action was the more surprising in that the vote came after the committee, over the protest of the administration, had eliminated all local payments toward the construction of the new project, had broadened the tributary provision, had expanded the board of review and had made sweeping provision for the compensation of all damages.

Following the action in the Senate the House committee which just had reported the Reid bill voted 14 to 6 to substitute the Jones bill, which was amended so as to extend the tributary provision to all rivers of the Mississippi Valley system. Authority was given to use $5,000,000 of the $325,000,000 authorized by the bill to add to the $7,500,000 carried in the War Department appropriation bill for the surveys of tributaries.

As passed by the Senate and accepted by the House committee the engineering board is to be composed of the Secretary of War, the Chief of Engineers, the President of the Mississippi River Commission and two civil engineers from civilian life. This board is to harmonize engineering differences and is empowered to report to Congress any alternative plan which it may decide is better. Another House amendment provides a salary of $10,000 per year for the president of the Mississippi River Commission and $7,500 for each member of the commission.

It is expected that the bill will encounter in the House no such easy sailing as in the Senate. Indications are that important amendments will be made when the bill comes before the representatives.

Contract Standards

Hearings are in progress before the judiciary committee of the House on Representative Cramton's bill to establish uniform requirements affecting government contracts. The bill is the outgrowth of the work of the Interdepartmental Board of Contracts and Adjustments, set up under the direction of the Bureau of the Budget. The measure is designed to unify and otherwise improve the contractural relations of the federal government and to remove conflicting and antiquated statutes.

The Associated General Contractors, American Engineering Council and various other interests have appeared in behalf of the bill, except Section 9, placing authority to liquidate damages for delay in the hands of the Comptroller General. It is the feeling of those opposed to this section that such authority should rest with the head of the department under which a given contract is executed. In place of the language now appearing in Section 9, they recommend that there be substituted the language originally adopted by the Interdepartmental Board of Contracts and Adjustments as follows:

"Whenever in contracts to which the United States is a party there is a provision for liquidated damage for delay, the head of the department concerned, stating his reasons in writing therefor, may remit the whole or any part of such damages as, in his opinion, may be just and equitable." Practically all of the governmental departments and independent agencies that enter into contracts are opposed to Section 9 as now written.

Progress of Muscle Shoals Bill

By the adoption of a government operation bill not greatly different from the Norris bill, which passed the Senate recently, the House military affairs committee has taken action which may lead to Muscle Shoals legislation at this session of Congress. The bill favored by the House committee proposes the operation of the properties by a government corporation to be administered by a commission of five members to be appointed by the President. The corporation is to be capitalized at $10,000,000 and will engage in the manufacture of fertilizer, with authority to sell surplus power.

Engineering Societies

Calendar

Annual Meetings

BUILDING OFFICIALS CONFERENCE OF AMERICA, Springfield, Mass.; Annual Meeting, Detroit, Mich., April 24-27.

AMERICAN WELDING SOCIETY, NEW YORK; Annual Meeting, New York, April 25-27.

NATIONAL FIRE PROTECTION ASSOCIATION, Boston, Mass.; Annual Meeting, Atlantic City, May 7-10.

AMERICAN ASSOCIATION OF ENGINEERS, Chicago; Annual Convention, El Paso, Tex., June 4, 5 and 6.

AMERICAN WATER WORKS ASSOCIATION, New York; Annual Convention, San Francisco, week of June 11.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION; Annual Meeting, University of North Carolina, June 25.

AMERICAN INSTITUTE OF QUANTITY SURVEYORS, Chicago; Annual Convention, New York, June 25-27.

Princeton Engineering Association—Carlton S. Proctor, of Moran, Maurice & Proctor, consulting engineers, New York City, has just been elected president of the Princeton Engineering Association. This is an organization of alumni which co-operates with Princeton University in the development of its engineering activities and plant.

SAN FRANCISCO SECTION of the American Society of Civil Engineers made a field trip on March 24 to inspect the South San Francisco plant of the Western Pipe & Steel Company, where 54-in. lock-bar pipe was being manufactured for the new San Andreas reservoir pipe line of the Spring Valley Water Company, and proceeded then to the reservoir, where the intake, tunnel and construction work on the pipe line was inspected. About 75 members and guests made the trip.

THE WESTERN SOCIETY OF ENGINEERS has announced its nominations for officers for 1928-29 as follows: President, John A. Garcia, consulting engineer; vice-presidents, William S. Monroe, president of Sargent & Lundy; D. J. Brumley, chief engineer of Chicago terminal improvements, Illinois Central Railroad, and W. O. Kurtz, general manager, Illinois Bell Telephone Company; treasurer, Leigh S. Keith, consulting engineer; trustee, George W. Hand, assistant to the president, Chicago & Northwestern Railway. For members of the Washington Award Commission: F. E. Morrow, assistant chief engineer of the Chicago & Western Indiana Railroad, and H. E. Bates, assistant chief engineer, Peoples Gas Light & Coke Company. All the above are located at Chicago.

THE INDIANAPOLIS SECTION of the Indiana Engineering Society sponsored a "concrete" meeting recently, in which it was joined by the Indiana Sand and Gravel Producers Association, the Indiana Highway Constructors, Inc., the Indiana Crushed Stone Producers, and the field engineers of the Indiana State Highway Commission. H. T. Giles, chief engineer of concrete control for the Blaw-Knox Company, and R. W. Crum, engineer of materials and tests of the Iowa State Highway Commission, were the principal speakers. Mr. Giles spoke on "Inundation" and its advantages in overcoming difficulties from the bulking of fine aggregates. Mr. Crum talked on the new specifications adopted by the Indiana commission requiring the proportioning of concrete aggregates by weight during the 1928 construction program. Authorities have pointed out that the radical departure from present methods may affect the material and construction industries, although highway commission engineers have expressed the belief that it will result in a better quality of concrete in construction work.

THE PROVIDENCE ENGINEERING SOCIETY formally opened its new lecture and club rooms on March 28. The entire week was celebrated as "housewarming week," with a different program each evening. On March 27 Major S. Frank Nolan, city engineer, spoke on "Municipal Wharf and Other Fields Point Developments." On March 29 Dr. Julius Berg, of Union College, gave an interesting talk on "Reminiscences of Heaviside and Steinmetz, Their Personalities and Work."

Personal Notes

M. W. TATLOCK, of Indianapolis, Ind., took up his duties as superintendent of the sewage treatment works, now under construction by the Dayton (Ohio) Department of Water, on Jan. 1. Mr. Tatlock is a graduate of Indiana University and taught physics in the Shortridge High School, Indianapolis, before taking up sewage treatment work. He was employed in various capacities on the Indianapolis sewage plant since the beginning of construction in 1919. When he left Indianapolis to take up the work at Dayton he was superintendent of the activated sludge plant. He will be acting resident engineer during the construction period and superintendent of operation upon completion of the plant in 1929.

THOMAS G. PIHLFELDT, engineer of bridges in the Department of Public Works, Chicago, has been made consulting engineer, and Paul Schioler has been appointed engineer of bridges.

H. C. HUNTER has been appointed division erecting manager of the American Bridge Company, with office at Chicago, to succeed the late K. L. Strickland.

C. NEIL BASS, former Tennessee state highway commissioner, has formed an association with Freeland, Roberts & Company, Nashville, to be known as C. Neil Bass-Freeland, Roberts & Company, associated engineers. The new company will specialize in promoting, laying out and supervising county highway and city street building programs. Freeland, Roberts & Company will continue to operate under that name independently of the association with Mr. Bass.

WILLIAM H. GOMPERT, formerly architect for the Board of Education of the City of New York, announces resumption of private practice with the architectural firm of Kenneth M. Murchison, New York City.

C. H. PURCELL has been appointed California state highway engineer, succeeding R. M. Morton. Mr. Purcell attended Stanford University and later graduated from the University of Nebraska. He has had 22 years' active experience in civil engineering. For fifteen years he has devoted himself exclusively to highway engineering and for seven years has been connected with the United States Bureau of Public Roads of Washington, D. C., with assignment as district engineer to the district comprising Oregon, Washington, Idaho and Montana, with headquarters at Portland.

JOHN J. DEVLIN has been appointed engineering assistant to the president of Manning, Maxwell & Moore, Inc., of New York. Mr. Devlin was graduated from Massachusetts Institute of Technology and Harvard University. After graduation he was engineer for the Boston & Albany Railroad and the Grand Trunk Railway and superintendent for various contractors, including the Bay State Dredging & Contracting Company and the New England Construction Company. During the war he was with the 301st Engineers, on the staff of General Bullard and in command of the 543d Engineers in three major engagements. After the war he became assistant to the bridge valuation engineer of the New York Central System and until Jan. 1, when he took up his new duties, he was engineer for the Portland Cement Association in charge of its New York City business.

Obituary

JOHN S. ELY, chief of the Philadelphia Water Bureau, died on March 31 in the University Hospital in that city. He was 54 years old. When Mr. Ely was selected for the Philadelphia post in February, he was division engineer, Department of Public Affairs, in charge of the water department, in Newark, N. J. He was destined never to take his desk in his new position, however. Shortly before he was to assume his duties he went to a hospital in Newark to have an operation on his jaw, and after the operation he went to Florida to recuperate. He returned to Philadelphia on March 26, accompanied by a physician and a nurse, and was taken from the train to the University Hospital. The following day he had hemorrhages and blood transfusion was resorted to, but he failed to rally.

WILLIAM H. MORGAN, president of the Morgan Engineering Company, of Alliance, Ohio, died on March 29 at the Union Memorial Hospital, Baltimore. Death followed an operation. Mr. Morgan was a member of the staff of George K. Nash, former Governor of Ohio, with the rank of Colonel.

CHARLES P. WEEKS, senior member of Weeks & Day, architects and engineers, of San Francisco, died in that city on March 25. Mr. Weeks was born in Ohio and after attending the state university there studied in Europe. He went to San Francisco in 1907 and a few years later organized the company that in recent years became one of the most prominent architectural firms in California.

SYLVESTER N. HOWARD, an old-time land surveyor of Chicago and a member of the firm of Greeley, Howard & Norlin, died at LaGrange, Ill., on March 26. Mr. Howard, who was 78 years of age, was an authority on old property records and an expert in determining intricate problems of lost property lines in the business district of Chicago, where land values are now very high. He was a member of the Illinois Society of Engineers.

Construction Equipment and Materials

A Section Devoted to What the Manufacturer Is Doing for the Engineer and Contractor

The Evils of Price Cutting

Discussion of the Warfare Between Purchasers and Sellers in This Buyers' Market

By Earl Whitehorne
Assistant Vice-President, McGraw-Hill Publishing Company, Inc., New York City

THE SITUATION upon which this article is based was found to be prominently existent in the electrical field. While it is not believed to be so pernicious in the civil engineering-construction field, it is not unheard of. Therefore, it behooves everyone to study the practice and to evaluate the consequences of a more general development of it. —EDITOR.

WITHIN the memory of this generation there has never been a time when business men were talking more about the ethics and the economics of price cutting. At the present time we are in a buyers' market, and there is excess capacity and overproduction in manufactured products and an intense competition for orders. Whereas in a sellers' market the salesman can play one buyer against another for a better price, the purchasing agent today is juggling one seller against another for a lower figure. At one time this was considered proper, but times have changed and what was once considered a fair game of bartering has come to be a matter of the economics of an industry. Modern business ethics have purged the manufacturing field of many practices that once were looked upon as quite legitimate. Now there is a great responsibility for business men to protect the economic health of the industry in which they are engaged.

How is this price cutting carried out? Coming down to cases—just what is the situation? Two things are happening: (1) purchasing agents of large buyers are rigorously applying the thumb screws to the manufacturers' salesmen and beating down price levels by ingenious methods of induced competition; (2) manufacturers in their eagerness for volume are weakly submitting to this pressure and cutting prices to get orders that net a loss and demoralize their market.

The seat of the present trouble, it would appear, lies in the old tradition of the secrecy of bids. After the bids are in the purchasing agent proceeds to privately play each sales representative against the other, telling each that he is high, inciting each to telephone the factory, whipsawing them with fear and hope until the last price cut has been exacted. The manufacturer, because of the traditional sanctity of bids, has been unable to demand a showdown when the bids are in, a chance to see whose price is really high.

Clearly, therefore, there are three things to be done: (1) secrecy should be eliminated on bids for standard listed apparatus, or at least the bids should be open to examination by any manufacturer who is called back and asked for a revision of his price; (2) salesmen should demand this frank showdown and should refuse to consider a concession without this evidence; (3) the holding of post mortems on competitive bids should be made standard practice among all electrical manufacturers, so that losers may analyze all bids and understand their lost business. This is lawful and is already being done to some extent.

But the seller should not be made to fight for this reform unaided. Purchasing agents individually and as nationally organized should also become the exponents of this idea. The chief concern of the buyer should be to see that he obtains a value proportionate with the price. The chief concern of the seller should be to see that he obtains a price commensurate with the value.

Tricks of the Purchaser

There are some manufacturers who have the courage to establish prices and maintain them, but there are some who lack courage or strength. Just so there are some purchasing agents who do not haggle. But there are others who seem to consider their function one of dollar squeezing and the ways that they operate can be illustrated by certain typical situations as follows:

(1) Where the purchasing agent gets the high bidder to cut on the indefinite promise of a large block of business next year.

(2) Where the buyer lies, giving the bidder false information as to his competitor's price.

(3) Where the large buyer demands special discounts for large volume, claiming that this volume carries the manufacturer's overhead and thus forces the large manufacturer's price down to where the small manufacturer cannot compete.

(4) Where very large buyers of electrical equipment that is used as part of a manufactured product threaten to make their own motor or control or whatever it is unless the price is cut.

(5) Where large utility holding companies argue that one of the savings possible through holding company operation should show up as savings in purchasing, and demand discounts over prices given to operating companies which eliminate the small manufacturer and force the large manufacturer's price below the margin that provides for the further development of bigger and better apparatus.

(6) Where purchasing agents apparently do not know how to buy because they have no facts to check with and no methods of evaluating bids, and therefore resort to haggling.

But what is the matter with the manufacturer, you will say, that he should submit to all this unsound and unfair treatment? The manufacturer right now finds himself in a buyers' market. He is involved in a mad scramble for orders until for every story reflecting upon the purchasing agent there are fourteen about the manufacturer and his salesmen. Some say that the first bids today are made for trading purposes only and that the bidders come to them before the ink is dry on the bids and offer to cut the prices. Therefore, the purchasing agents say, they too must use trading methods.

Tricks of the Manufacturer

(1) The large manufacturer uses the lump sum bids as a lever to lower prices on individual products to compete with the small producer who specializes in that line. It is said that at times this is so manipulated that it has the effect of a straight price cut.

(2) Allowances are made on old equipment taken back that range all the way from a reasonable scrap allowance to the full original price.

(3) Some manufacturers are making extravagant contributions in preliminary engineering expense for detailed working data that is out of all reason and constitutes a price consideration because it puts an undue extra burden on the profit.

(4) Financial affiliations between some manufacturers and the utility companies are used to bring pressure from on high to throw the order.

(5) Reciprocity arrangements are drawn into competitive bids to an extent that overshadows the actual values involved and works an injustice upon bidders who are invited to compete with the assumption that it is to be a fair and open contest.

(6) And then there are the everyday conditions of price cutting where the manufacturer loses his nerve and pares his price for no other reason than to get the order, and camouflages it with all manner of alibis and explanations, such as a mistake in figuring, or new information, or an

unexpectedly favorable purchase of materials.

Some say that this has always been the condition. But is that a reason? There are many time-honored practices that some day will give way to the onward march of principle and be changed. There are many things that men used to do that have been stopped and are not countenanced today. After all, it gets down to a very simple consideration of plain honesty. The only difference between picking a man's pocket and cutting prices is that the latter has not yet lost its social standing.

TWO OBJECTIVES

Fundamentally it seems to me there are two things to be done:

(1) By the purchaser—

Industry needs more intelligent buying. It needs purchasing agents who know the values of the equipment they buy, and make of their function something more than an adroit matching of prices. It needs frank open recognition of the fact that what is bought must be paid for and that bids which embrace elements of engineering and of service as well as the delivered product, cannot be compared by a mere tallying of the total cost figures.

(2) By the manufacturer—

Industry needs more sincerity in selling. It needs manufacturers who consider that a bid is a word given, an honest offer of service to a friend, and not just a gesture in a sparring match. Such a bid is the equivalent of an open bid because there is no trick in it. It is not subject to a revision, any more than the written word of that manufacturer is subject to question, because his honor is involved.

All this will not happen at once. But industry can work toward it. And the logical approach to it is for the seller to refuse longer to cut his price because the buyer tells him to. Let him at least begin to protect himself by making sure that the other bids that he is asked to beat are comparable and that the purchasing agent is not lying. If he is asked to refigure after the bids are in, let him at least demand that all the bids be opened to inspection. Also, it is time the manufacturer knew a little more about the reasons why he loses orders, through regularly organized post mortem studies of the bids on his closed business.

Some day price cutting will pass out of industry. And men will wonder why it was that we could have been so long blind to economic truth.

Recommended Paving Brick Sizes Remain the Same for 1928

At the annual meeting, March 23, of the Standing Committee for Simplified Practice, Recommendation No. 1, Paving Brick, in the Department of Commerce, Washington, D. C., the existing simplified practice recommendation was reaffirmed without change for another year. The committee reported that the average of adherence to the recommendations was 79.6 per cent for the year 1927.

G. F. Schlesinger, director of state highway, Columbus, Ohio, was elected chairman of the committee, succeeding E. J. Mehren, vice-president, McGraw-Hill Publishing Company, Inc., who tendered his resignation as chairman and member of the committee. E. E. Duff, former secretary of the National Paving Brick Manufacturers Association, also tendered his resignation as a member of the committee.

Those attending the conference were E. L. Beller, National Paving Brick Manufacturers' Association, Chicago; R. Keith Compton, Am. Soc. C. E., Richmond, Va.; T. R. Lawson, American Society for Municipal Improvements, Buffalo, N. Y.; E. E. McCullogh, U. S. Chamber of Commerce, Washington, D. C.; O. W. Renkert, American Ceramic Society, Canton, Ohio; G. F. Schlesinger, American Association of State Highway Officials, Columbus, Ohio; F. L. Manning, Portsmouth, Ohio; and H. R. Colwell, Division of Simplified Practice.

Concrete Reinforcing Steel Institute Meets

The Concrete Reinforcing Steel Institute held its fourth annual meeting at the Edgewater Gulf Hotel, Biloxi, Miss., March 19-21, 1928. The members adopted, as a tentative standard, the joint building code which was similarly adopted at a recent meeting of the American Concrete Institute in Philadelphia. The United States Department of Commerce co-operated in a conference to standardize "Form Dimensions for Concrete Ribbed Floor Construction" (*Engineering News-Record*, March 15, 1928, p. 459).

The following points are taken from the address of President George W. Routh, Jr., reviewing the work of the past year: The distribution of the Institute Handbook has reached nearly 25,000 copies, the handbook being taken as a standard by many architects, engineers and technical schools. Most members have adopted the standard contract covering removable forms, standard bar sales contract and standard rules for bundling and tagging. With the adoption of intermediate grade as the new single billet standard for concrete reinforcement, much work had to be done to get cities to revise their building codes and specifications. The new standard went into effect on Jan. 1, 1928, and it was expected that stocks would be cleared of most other grades by March 1, 1928.

Mr. Routh also stated that a proposed special department for manufacturers and dealers in forms used in concrete ribbed floor construction has been informally discussed. The steel mills not only have consistently refused to support the institute but have protested to the Department of Commerce against the adoption of the "intermediate" grade as the single standard grade of new billet reinforcement.

The following officers and directors were elected: President George E. Routh, Jr., of Chicago; Vice-President C. Louis Meyer, of Omaha, and Treasurer Hugh J. Baker, of Indianapolis, were re-elected for another year. A. E. Lindau, of Chicago, was re-elected as director for another three years, and O. W. Irwin, of Youngstown, was elected director for a similar period in place of Gustav Kahn, resigned. M. A. Beeman, of Chicago, was reappointed secretary, and R. W. Johnson continues as engineer for another year.

Conference on Slate, Cement and Steel in Pennsylvania

Several committees are now at work in arranging for a three-day conference on slate, cement and steel, to be known as the Lehigh Valley Mineral Industries Conference, which is to be held at Easton, Pa., April 25, 26 and 27. The conference is planned to afford all engineers, associations and industries an opportunity to acquire a greater knowledge and appreciation of the Lehigh Valley district and of its slate, cement and steel as important materials of construction.

The preliminary program is now being distributed by the conference chairman, Prof. William B. Plank, Lafayette College, Easton, and by the conference secretary, D. Knickerbacker Boyd, 112 South Sixteenth St., Philadelphia. Among the features on the program are: Meeting of A.S.T.M. committee D-16 on slate; technical session on slate and its uses; inspection trip to the Alpha Portland Cement Company plant; inspection of slate quarries and mills; and inspection of the plant of the Bethlehem Steel Company at Bethlehem, Pa.

New Publications

Valve Data—MICHIGAN VALVE & FOUNDRY COMPANY, Detroit, Mich., has made available a loose-leaf folder of data on its hydrant valves and sluice gates. The first 25 pages are designated as a handbook of design and specifications and discuss these subjects from a general point of view rather than from one bearing directly on the company's products. This is followed by 48 folders of working prints, each giving dimensions and sizes of the company's various products. Other folders can be added as they are made available.

Centrifugal Pumps—PENNSYLVANIA PUMP & COMPRESSOR COMPANY, Easton, Pa., in its bulletin No. 209 describes its double-suction, single-stage centrifugal pumps, giving illustrations and descriptions of the various detail parts, such as casing, shaft and impeller, wearing rings, stuffing boxes, flexible couplings and base plates. Characteristic curves are included as well as information with regard to installing the units.

Business Side of Construction

Facts and Events That Affect Cost and Volume

1928 First Quarter Contracts Exceed Last Year's by 25 Per Cent

Contracts reported by *Engineering News-Record* during the five weeks of March, 1928, totaled $379,521,000. This was 41 per cent greater than February awards and 38 per cent more than in March, 1927.

Every section of the country showed a gain compared with average weekly figures for last month, ranging from a 97 per cent increase in New England to an 11 per cent gain in the South. Compared with a year ago, March totals showed increases in all sections except West of the Mississippi, where a 15 per cent decline was shown.

This year to date compared with last showed the following per cent differences: Total United States, +25; New England, —3; Middle Atlantic, +70; South, +29; Middle West, +23; West of Mississippi, +2, and Far West, —13. Awards for bridges, streets and roads, industrial buildings, commercial buildings and federal government work showed greater activity than during the first three months of 1927. Street and road awards were 75 per cent higher than last year; actual values were $790,795,000 in 1928, compared with $630,448,000 in 1927.

The outstanding feature in the awards let during March, 1928, was the large commercial building total for the Middle Atlantic states. This value, $113,428,000, constituted 30 per cent of the total awards. The average monthly commercial awards in this section during 1926 were $40,335,000, in 1927 $52,440,000, and thus far in 1928, $72,300,000. Several of the large March contracts were: In New York, office and store, $23,000,000; office and printing, $6,000,000; apartment hotel, $6,000,000; in Chicago, office and printing, $10,000,000; theater and office, $20,000,000; club, office and store, $4,000,000. There were 25 commercial building awards outside of New York City that exceeded $1,000,000, and these totaled $32,650,000. New York commercial awards totaled $81,451,000 and Illinois awards totaled $43,236,000.

Total private awards for March, 1928, exceeded those of a year ago by 56 per cent, whereas only an 8 per cent increase is shown in public contracts. The summer months are peak months for public awards because of the large volume of street and road work, which thus far in 1928 constitutes 47.5 per cent of all public contracts.

Public contracts in 1928 and 1927 to date consist of the following class totals:

	1928	1927
Waterworks	$7,365,000	$16,807,000
Sewers	13,120,000	20,002,000
Bridges	16,065,000	8,780,000
Excavations, etc.	4,175,000	5,509,000
Streets and roads	114,993,000	65,783,000
Buildings	46,870,000	49,438,000
Federal government	12,248,000	10,464,000
Unclassified	26,912,000	28,388,000
Total	$241,748,000	$205,171,000

Business in General Continues to Show Substantial Activity

Despite some irregularity in general business, those industries which have shown marked improvement since the first of the year continue that trend. The leaders among these industries are construction, steel, and automotive. Textiles have not improved their unfavorable position. Total business failures in February, 1928, were more numerous than in February, 1927. General retail trade activity in February was the same as a year ago.

Automobile production in the United States totaled 323,368 cars and trucks in February, 1928, or about 6 per cent above last year. The gain has been only in passenger car production, as both January and February truck production figures were under a year ago.

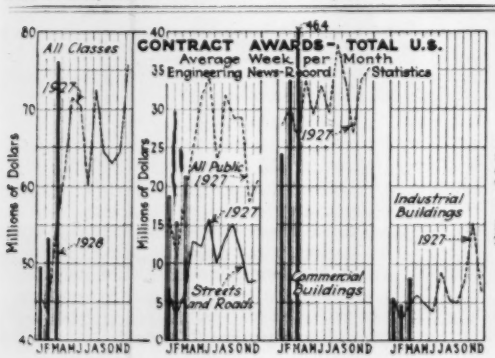
The *Electrical World* index of monthly productive activity based on consumption of electrical energy by large manufacturing plants has risen considerably since the low point of December, 1927. January and February, 1928, are well above the same period last year. The volume of manufacture as measured by the index of the Harvard Economic Service is less than 1 per cent under the first two months of 1927.

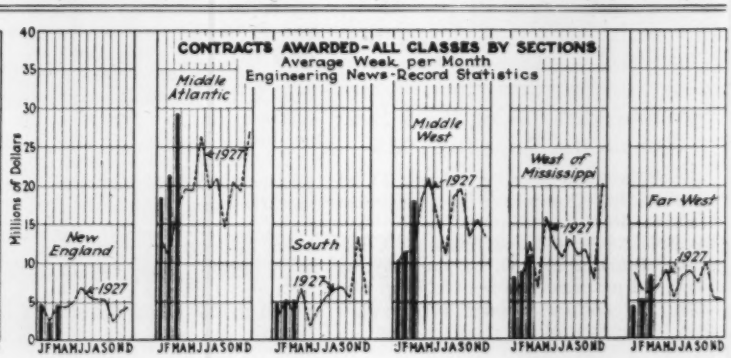
Continued high activity prevails in the iron and steel industry. Pig iron output in March totaled 3,199,674 tons, according to *Iron Age* compilations. February production of ingots was 6 per cent higher than the January daily average. United States Steel Corporation unfilled orders were 800,000 tons larger on March 1, 1928, than a year ago. New orders for fabricated structural steel totaled 210,000 and 270,000 tons in Jan-

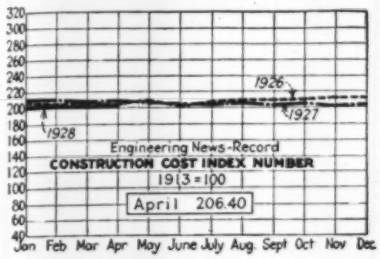
VALUE OF CONTRACTS BY SECTIONS IN THE UNITED STATES AND TOTAL FOR CANADA—MARCH, 1928

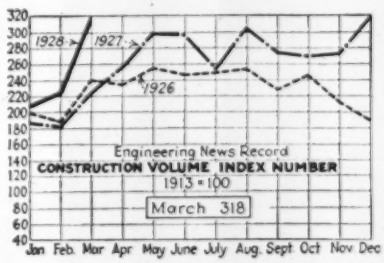
Thousands of dollars (-000 omitted)

	New England	Middle Atlantic	South	Middle West	West of Mississippi	Far West	United States	Jan. 1 to Date, U. S.	Canada
Waterworks	.....	$567	$148	$623	$899	$466	$2,703	$7,365	$144
Sewers	.....	1,208	201	3,999	996	1,765	8,169	13,120	253
Bridges	$288	2,190	153	2,112	2,289	524	7,556	22,623	500
Excavation, drainage, etc.	25	137	52	245	126	34	619	4,225	259
Streets and roads	222	8,163	6,155	15,103	17,300	5,023	51,966	114,993	10,488
Industrial building	6,616	8,635	10,860	7,288	4,510	2,642	40,551	79,914	640
Commercial building	14,899	113,428	7,491	59,392	15,265	21,756	232,231	462,296	3,610
Federal government	.....	3,650	459	64	1,485	646	6,304	12,248	.....
Unclassified	140	7,629	946	1,202	11,183	8,322	29,422	74,011	6,500
March, 1928	22,190	145,607	26,465	90,028	54,053	41,178	379,521	.....	22,394
February, 1928	9,020	84,820	18,962	45,281	34,706	20,501	213,290	.....	4,744
March, 1927	21,984	84,256	16,769	56,944	63,304	30,181	273,438	.....	5,309
Year to date, 1928	48,550	303,231	64,504	175,589	120,440	79,481	.....	790,795	39,713
Year to date, 1927	50,446	178,076	50,493	142,880	117,868	90,685	.....	630,448	13,931









ENGINEERING NEWS-RECORD CONSTRUCTION COST AND VOLUME INDEX NUMBERS

uary and February, respectively. Shipments in February were 22,500 tons more than in January, 1928.

Lumber production for the first twelve weeks in 1928 was 106,403,000 ft. more than in the same period last year. Shipments also were higher, by 111,710,000 ft., and orders exceed last year's by 122,922,000 ft. Cement shipments were about the same in February, 1928, as during the preceding month, and production declined about a million barrels. Foreign cement imported showed a sharp downward trend throughout 1926 and only a slight upward trend in 1927. Brick stocks on March 1, 1928, were practically the same as a year ago and shipments during February, 1928, exceeded last year's by 6 per cent.

Revenue freight loadings continue to be under the totals for January, February and the first three weeks of March last year. The week ended March 17 showed increases over the preceding week for loadings of livestock, merchandise less than carload lots, and miscellaneous. Average weekly loadings in March have been higher than in January or February, 1928, but lower than in March, 1927. In analyzing car loadings, several statements have been made recently that a comparison of 1928 with 1927 figures should be qualified by the fact that unusually large coal shipments took place during the first quarter of 1927 in preparation for the April 1 strike. Coal and coke loadings comprise about 20 per cent of the total, and merchandise, l.c.l. and miscellaneous freight comprise 25 and 35 per cent, respectively, and smaller totals for the latter classes of freight have been reported during 1928 to date than a year ago, which would indicate that the decline cannot be attributed to coal loadings alone.

Trade activity in 1928 as measured by bank debits outside of New York City has been higher than last year except for one week in January, two weeks in February and one week in March. The latest report for the week ended March 21, 1928, showed the highest total since the first two weeks of this year and exceeded all 1927 weekly totals except the first one in January and two weeks of October. Debits, including New York City, have been higher during 1928 than in January and February, 1927, and the three weeks of March are also ahead of a year ago—49.94 billions of dollars compared with 41.12 billions.

Unusual activity in the stock market has continued for an unprecedented length of time. The average daily shares traded during the first quarter of 1926 and 1927 were about 1¾ millions while thus far in 1928 the average is 2½ millions, with 4¾ millions on March 30. Average stock prices since March, 1926, have been climbing rapidly to the high points on March 30, 1928, of $214.45 for twenty industrials and $141.96 for twenty rails.

Bond sales to date total $838,381,000; a year ago they totaled $1,022,613,000.

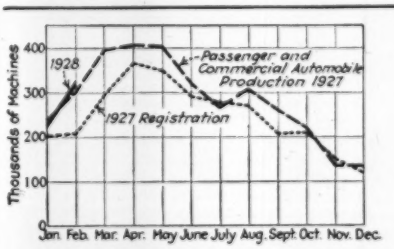
Volume Index Second Highest; Slight Rise in Cost Index

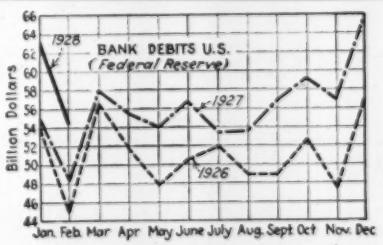
Slight increases in steel prices and wages have lifted the *Engineering News-Record* Construction Cost Index Number 0.8 per cent above the March 1 value. Steel shapes at Pittsburgh now cost $1.90 compared with $1.85 a month ago. A record-breaking March contract volume has boosted the *E. N.-R.* Volume Index to 318 compared with 225 for March, 1927. The figures, with comparisons are below.

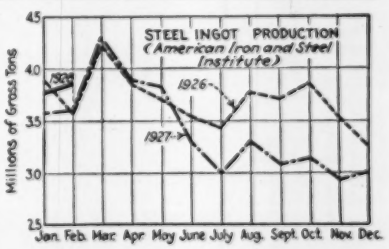
E. N.-R. Cost Index		E. N.-R. Volume Index	
April, 1928	**206.40**	**March, 1928**	**318**
March, 1928	204.65	February, 1928	225
April, 1927	209.00	March, 1927	226
Peak, June, 1920	273.80	1927 (average)	263
1927 (average)	206.24	1926 (average)	228
1913 (average)	100.00	1913	100
1927 (Cost)		1927 (Volume)	
January	211.50	January	187
February	210.15	February	182
March	208.80	March	226
April	209.00	April	257
May	206.80	May	299
June	205.55	June	297
July	203.68	July	252
August	205.50	August	306
September	203.60	September	273
October	204.40	October	269
November	201.98	November	272
December	203.90	December	319

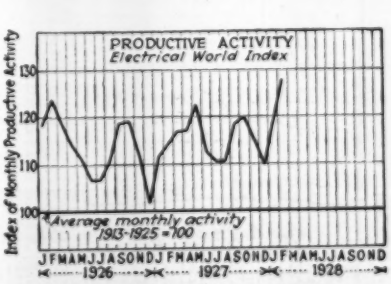
From a low average price of $91.47 for 40 bonds in August, 1925, there was an increase to $99.48 on Jan. 13, 1928, and after a slight decline to $98.99 on March 5, the price on March 30 was $99.31.

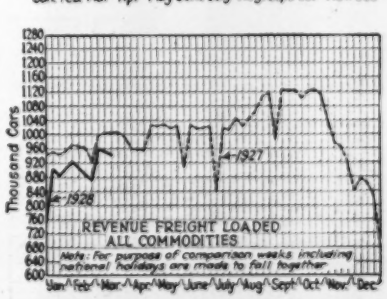
Money rates have firmed very little in recent months. Call loan renewal rates had a downward trend throughout 1927, and from a low average daily rate of 3.60 per cent for November there has been an increase to about 4.40, which has been the approximate average since December. Prime commercial paper remained at 4 per cent from August until March, when the prevailing rate has ranged from 4@4¼ per cent. Prime bankers' acceptances have increased from 3⅛ per cent in September, 1927, to 3½ in February and March, 1928. Time loans have likewise increased from a low point of 4@4¼ in the summer of 1927 to 4½@4⅝ during February and

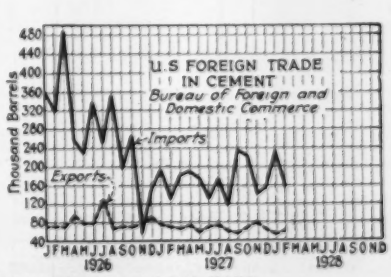

Thousands of Machines
1928
Passenger and Commercial Automobile Production 1927
1927 Registration
Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec.




Millions of Gross Tons
STEEL INGOT PRODUCTION
(American Iron and Steel Institute)
1926
1927
Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec.


Index of Monthly Productive Activity
PRODUCTIVE ACTIVITY
Electrical World Index
Average monthly activity
1913-1925=100
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1926 1927 1928


Thousand Cars
1927
1928
REVENUE FREIGHT LOADED
ALL COMMODITIES
Note: For purpose of comparison weeks including national holidays are made to fall together
Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec.


Thousand Barrels
U.S FOREIGN TRADE
IN CEMENT
Bureau of Foreign and Domestic Commerce
Imports
Exports
J F M A M J J A S O N D J F M A M J J A S O N D
1926 1927 1928

STEEL AND AUTOMOTIVE PRODUCTION—CHECKS CASHED AT BANKS—FREIGHT LOADINGS

March. The Federal Reserve discount rates in all districts increased to 4 per cent from 3½ in February.

Total bond offerings since Jan. 1, 1928, amounted to $1,698,230,000. This is only 1 per cent less than the first thirteen weeks of 1927, during which time offerings totaled $1,712,940,000. Municipal issues averaged higher during the five weeks of March, 1928, than preceding months this year. The average weekly municipal offerings for the first three months of 1928 compared with last year are as follows:

	1928	1927
January	$17,250,000	$31,250,000
February	5,700,000	8,410,000
March	26,960,000	9,640,000

Price Rises Reflect Slight Increase in Demand

The general wholesale price level is slightly higher than a month ago or than a year ago. The following commodities have advanced: grains, meats, cattle feed, leather, and woolen and worsted textiles. Declines were registered in dairy products, bituminous coal, coke, drugs, pharmaceuticals, fertilizers, house furnishings, rubber, non-ferrous metals and paint stuffs.

Building materials as a group showed a consistent downward trend from November, 1926, to January, 1928. Throughout the first quarter of 1928, however, marked firmness has been apparent in steel, lumber, brick and several of the minor materials. Building materials are approximately 5 per cent under the cost level of general wholesale commodities.

General advances have been reported in the following materials: rivets, 15c. per 100 lb. at mill; asphalt, package, 50c. per ton at Western points; wire nails, 10@15c. per 100-lb. keg at mill; steel sheet piling, 5@10c. per 100 lb. at mill; copper sulphate for water treatment, 5c. per 100 lb. at New York; heavy melting steel scrap, $1.25 per ton, f.o.b. Chicago; cast-iron pipe, $1 per ton at Burlington and Birmingham mills.

Price declines occurred as follows: black and galvanized steel sheets, 10c. per 100 lb. at mill; ship spikes, 25c. at mill; railway tie plates, 10c. at mill; expanded metal lath, $1.50 per 100 sq.yd. at Western and Southern distributing centers.

March lumber declines were more pronounced in fir than in pine. Douglas fir timbers dropped $2 per 1,000 ft. in San Francisco and 50c. in Chicago. Twenty-three Chicago lumber-yard managers, on the other hand, report increasing demand for lumber and also more than the usual number of inquiries from contractors for prices on which to base bidding. Lumber yard stocks are reported low on dimension material in the Minneapolis district.

Few Changes in Labor Rates and Employment Situation

Secretary Davis' report on unemployment, submitted to the Senate last week, shows approximately 1,874,000 persons out of work, or about 7 per cent fewer than were employed in the high-production year 1925. In addition to closing of industrial plants, the Secretary lists as contributory causes of present unemployment the floods in the Mississippi Valley and in New England, the Florida tornado, and disturbance in the bituminous coal fields. The report says "prompt relief for one class is due from the government's elaborate building program, from similar programs of states, municipalities and counties and from private building and construction."

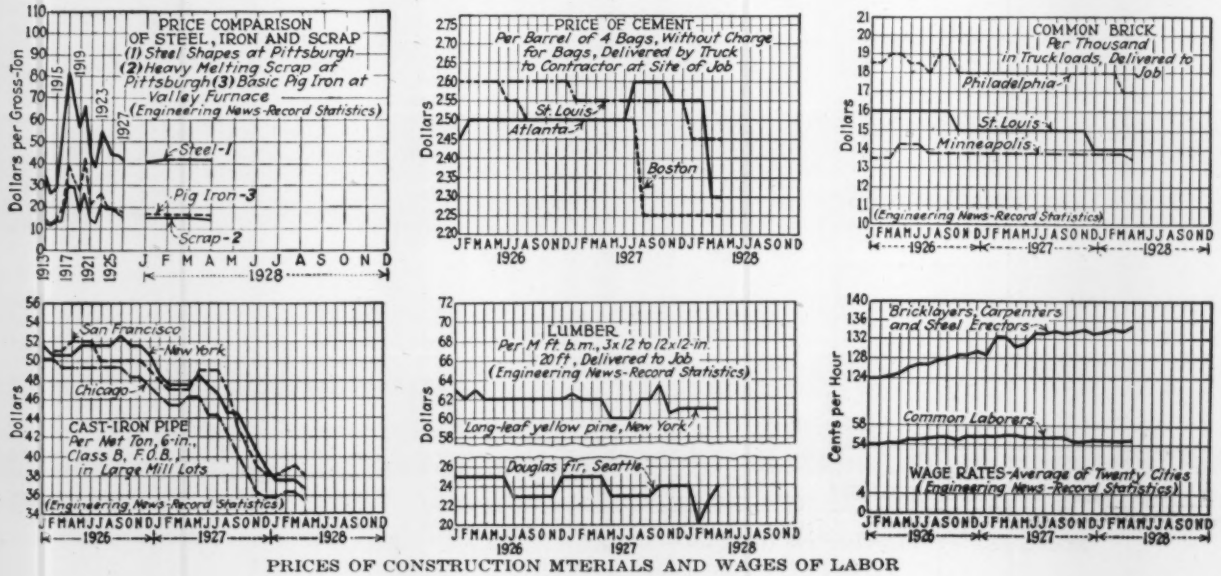
Three strikes in the building trades developed during the last month. In New York 200 bricklayers on four building projects went on strike in protest against the employment of non-union steel workers on these jobs. A lockout of 2,500 structural steel erectors followed the bricklayers' strike in an effort to force the bricklayers back to work. Settlement is reported as having been reached March 29. A strike growing out of wage dispute affected 550 glass workers at the Butler, Pa., plant of the Standard Plate Glass Company. In Newark plumbers and steamfitters were withdrawn from the New Jersey Bell Telephone Company's building on the order of the international union, as an act of sympathy with a strike involving these crafts on the telephone company's project in Oklahoma City. In Boston carpenters struck as the result of jurisdictional disputes with sheet-metal workers and lathers. Building trades demand an average increase of 12½c. per hour. Employers have already voted against allowing this.

The five-day week was an issue in several recent trade disputes. In Seattle a deadlock prevails between building crafts and employers over wage agreements with common laborers and granting of the five-day week to carpenters. Carpenters in Paterson, N. J., demand an advance of 80c. and laborers $1 per day, and the five-day week. Painters in Chicago request the five-day week as a means of absorbing some of the 5,000 men of that craft now idle. Building trades in Monmouth County, New Jersey, are pressing for the five-day week. Painters and paperhangers in Orange, N. J., request an advance of $1 per day over the old scale of $11, which has remained in effect during the last two years. Plasterers in Sioux City, Iowa, demand an increase of $2 and carpenters $1 per day over rates prevailing prior to April 1.

Building trades wages averaged for the country show skilled mechanics receiving $1.35 per hour, against $1.33⅓ last month and $1.30 in April, 1927.

Following are the hourly wage changes:

	April	March
Bricklayers, Birmingham	$1.33½	$1.50
Hoisting engineers, Dallas	1.25	1.00
Hod-carriers, Montreal	0.40	0.45
Pile drivers, Dallas	1.25	1.00
Common laborers, Dallas	0.35@0.50	0.30@0.50
Kansas City, Mo.	0.40@0.75	0.35@0.75



PRICES OF CONSTRUCTION MTERIALS AND WAGES OF LABOR

E. N.-R. Prices of Construction Materials

Price advances since last month are indicated by **heavy type**; declines by *italics*

PIG IRON—Per gross ton, f.o.b.:

CINCINNATI	
No. 2 Southern (silicon 2.25@2.75)	$21.44
Northern Basic	20.89
No. 2 Southern Ohio (silicon 1.75@2.25)	21.19
NEW YORK, tidewater delivery	
Southern No. 2 (silicon 2.25@2.75)	25.62
BIRMINGHAM	
No. 2 Foundry (silicon 2.25@2.75)	16.00
PHILADELPHIA	
Eastern Pa., No. 2X (silicon 2.25@2.75)	21.76
Virginia No. 2 (silicon 2.25@2.75)	27.17
Basic	21.26
CHICAGO	
No. 2 Foundry Local (silicon 1.75@2.25)	20.00
No. 2 Foundry Southern (silicon 2.25@2.75)	22.80
PITTSBURGH, including freight charge ($1.75) from the Valley	
No. 2 Foundry Valley (silicon 1.75@2.25)	20.26
Basic	19.26
Bessemer	21.26

SCRAP—The prices following are f.o.b. per ton paid by dealers:

	New York Per Gross Ton	Chicago Per Net Ton	Birmingham Per Gross Ton
No. 1 railroad wrought	*$10.00*@$10.50	$11.25@$11.75	$11.00@$11.50
Stove plate	*8.50*@ 9.00	*12.00*@ *12.50*	9.00@ 9.50
No. 1 machinery cast	*12.50*@ 14.00	13.75@ 14.25	12.50@ 14.00
Machine shop turnings	6.75@ 7.50	*7.00*@ *7.50*	7.00@ 7.25
Cast borings	6.75@ 7.50	**9.50@ 10.00**	7.25@ 7.50
Railroad malleable	*10.00*	**12.50@ 13.00**	10.25@ 10.75
Re-rolling rails	10.50@ 11.00	**13.50@ 14.00**	10.25@ 10.75
Re-laying rails	23.00@ 24.00		23.00@ 24.00
Heavy melting steel	7.00@ 10.75	**12.50@ 13.00**	
Iron and steel pipe	*8.25*		

Railway Supplies

STEEL RAILS—Per gross ton f.o.b. for carloads:

	Pittsburgh	Birmingham	Chicago
Standard bessemer rails	$43.00	$43.00	$43.00
Standard openhearth rails	43.00	43.00	43.00
Light rails, 8 to 10 lb.		34@36	36@38
Light rails, 12 to 14 lb.		34@36	36@38
Light rails, 25 to 45 lb.	36.00	34@36	36@38
Re-rolled rails	*31*@32	34@36	

RAILWAY TIES—For fair-sized orders f. o. b., the following prices, per tie hold:

		6 In. x 8 In. by 8 Ft.	7 In. x 9 In. by 8½ Ft.
New York	Long-leaf sap pine, untreated	$1.10	$1.30
	Creosoted—prices on application.		
Birmingham	White oak, heart, untreated	1.25	1.45
	White oak, creosoted	1.70	1.90
St. Louis	Sap pine or cypress, untreated	95@1.05	1.30@1.40
	Pine or cypress, creosoted	1.75	2.10
Chicago	White oak, heart, untreated	1.40	1.78
	Oak, empty cell, creosoted	1.80	2.40
	Oak, zinc treated	1.60	2.10
San Francisco	Douglas fir, green, untreated	.84	1.14
	Douglas fir, empty cell, creosoted	1.70	2.25

TRACK SUPPLIES—Per 100 lb. f.o.b. Pittsburgh mill for carloads together with warehouse prices at other places named:

	Pittsburgh	Chicago	St. Louis	San Francisco	Birmingham
Standard spikes, ⅝-in. and larger	$2.75@2.80	$3.55	$3.65	$3.85	$3.00
Track bolts	3.80	4.55	4.65	5.35	3.90
Standard section angle bars, splice bars or fish plates	2.75	3.40	4.25	4.25	
Tie plates	*2.15*				

Pipe

WROUGHT STEEL AND IRON PIPE—The following discounts from list are to jobbers for carloads at Pittsburgh mill:

BUTT WELD

Inches	Steel Black	Steel Galv.	Inches	Iron Black	Iron Galv.
1 to 3	62	50½	1 to 1½	30	13

LAP WELD

1	55	43½	2	23	7
2½ to 6	59	47½	2½	26	11
2 and 8	56	43½	3 to 6	28	13
9 and 10	54	41½	7 to 12	26	11
11 and 12	53	40½			

BUTT WELD, EXTRA STRONG, PLAIN ENDS

1 to 1½	60	49½	1 to 1½	30	14
2 to 3	61	50½			

LAP WELD, EXTRA STRONG, PLAIN ENDS

2	53	42½	2	23	9
2½ to 4	57	46½	2½ to 4	29	15
4½ to 6	56	45½	4½ to 6	28	14
7 and 8	52	39½	7 and 8	21	4
9 and 10	45	32½	9 to 12	16	2
11 and 12	44	31½			

WROUGHT-STEEL PIPE—From warehouses at the places named the following discounts from list hold for welded steel pipe:

	Black			Galvanized		
	New York	Chicago	St. Louis	New York	Chicago	St. Louis
1 to 3 in. butt welded	53%	54%	49%	39%	41%	36%
2½ to 6 in. lap welded	48%	51%	46%	35%	38%	33%

WROUGHT STEEL PIPE LIST

Size, Inches	List Price per Foot	Diameter in Inches—External	Diameter in Inches—Internal	Thickness Inches
1	$0.17	1.315	1.049	.133
1¼	.23	1.66	1.38	.14
1½	.27½	1.9	1.61	.145
2	.37	2.375	2.067	.154
2½	.58½	2.875	2.469	.203
3	.76½	3.5	3.068	.216
3½	.92	4.0	3.548	.226
4	1.09	4.5	4.026	.237
4½	1.27	5.0	4.506	.247
5	1.48	5.563	5.047	.258
6	1.92	6.625	6.065	.28
7	2.38	7.625	7.023	.301
8	2.50	8.625	8.071	.277
8	2.88	8.625	7.981	.322
9	3.45	9.625	8.941	.342
10	3.20	10.750	10.192	.279
10	3.50	10.750	10.136	.307
10	4.12	10.750	10.020	.365
11	4.63	11.750	11.000	.375
12	4.50	12.750	12.090	.330
12	5.07	12.750	12.000	.375

CAST-IRON PIPE—Prices per net ton for Class B and heavier, f. o. b., in large mill lots:

	Birmingham	Burlington, N. J.	New York
4 in.	**$31.00**	**$38.00**	**$40.60**
6 in. and over	**28.00**	**35.00**	**37.60**

	Pittsburgh	Chicago	St. Louis	San Francisco
4 in.	**$39.50**	**$39.20**	**$33.60**	**$42.00**
6 in. and over	**36.50**	**36.20**	**33.60**	**39.00**

Gas pipe and Class "A," $3.00 per ton extra.

CLAY DRAIN TILE—Prices are delivered per 1,000 lin.ft.:

Size, In.	New York	St. Louis	Birmingham	San Francisco	Dallas
3	$45.00	$50.00	$45.00		$73.00
4	56.00	50.00	56.00	$76.50	90.00
5			80.00	97.75	118.00
6	90.00	85.00	105.00	127.50	150.00
8	150.00	195.00	175.00	212.50	210.00

SEWER PIPE—Prices are delivered in cents per foot for standard pipe; single strength 6, 8 and 12-in. and double strength, 18, 24, 30 and 36-in.:

	6-In.	8-In.	12-In.	18-In.	24-In.	30-In.	36-In.
Atlanta	$0.15	$0.25	$0.425		$1.625		
Baltimore		.203	.3915		1.305		$4.715
Birmingham	*.135*	*.2215*	*.4015*	$1.4625	2.665	$3.96	5.06
Boston	.1375	.275	.517		1.98		5.50
Cincinnati		.17	.405		1.35		4.8175
Chicago	.117	.182	.351	1.00	1.80	3.75	5.00
Dallas	.35	.50	.90	1.70	3.00		
Denver	.185	*.265*	**.48**	1.35	*1.65*		
Detroit	.18	.28	.6075		2.70		
Kansas City (*f.o.b.*)			.52		1.90		3.80
Los Angeles		.2825	.5085		1.74		
Montreal		.45	.75		2.60		
Minneapolis (*f.o.b.*)	.1575	.25	.45	1.05	1.80	.375	4.94
New Orleans	.195	.325	.5525	1.105	2.112		
New York	.22	.35	.61	1.50	2.70	5.12	7.91
Philadelphia		.235	.38		1.33		3.32
Pittsburgh	.1125	.175	.3375	.625	1.125	2.664	4.305
St. Louis	.1645	.26	.468	1.092	1.872	3.65	4.80
San Francisco	.21	.30	.555	1.32	2.16	3.60	
Seattle		.35	.63		2.52		

Road and Paving Materials

ROAD OILS—Price per gal. in tank cars, 8,000 gal. minimum; f.o.b., places named:

New York, 40@50% asphalt	(at terminal)	$0.0725@ $0.075
New York, 50@60% asphalt	(at terminal)	.0675@ .072
St. Louis, 40@50% asphalt		*.045*
St. Louis, 50@60% asphalt		*.05*
Birmingham, 50@60%		.0475
Dallas, 40@50% asphalt		.06
Dallas, 50@60% asphalt		.062

E. N.-R. Prices of Construction Materials

ASPHALT—Price per ton in packages (350-lb. bbls. or 425-lb. drums) and in bulk in carload lots, f.o.b. points listed:

	Package	Bulk
New York (*Texas*)	$24.50	.....
Boston (*Mexican*)	24.00	$19.00
Chicago (*Texas*)	24.50	21.30
San Francisco, (*f.o.b. refinery, Oleum, Calif.*)	18.00	12.00
Dallas (*Texas*)	26.00	.....
Seattle, (*"D" grade, California, f.o.b. Richmond refinery*)	19.50	13.50
Denver (*California*)	24.00	.....
Minneapolis, (*Standolind f.o.b. Twin Cities*)	28.10	22.10
St. Louis (*Mexican*)	*23.50–24.50*	*19.50–20.50*
Baltimore (*Standard Oil f.o.b. refinery*)	22.50	18.50
Montreal (*Imperial*)	28.00	21.50
Atlanta (*Mexican*)	24.55	20.40
Detroit (*Mexican*)	24.00	19.00
Cincinnati (*Kentucky Rock*)	.....	11.65
Maurer, N. J. (*Bermudez*)	30.00	.....
Maurer, N. J. (*Trinidad*)	23.00	.....
Philadelphia (*Mexican*)	20.00	18.00
Kansas City, Mo. (*Texas*)	*27.30*	*22.30*
Los Angeles (*"D" grade, California f.o.b. El Segundo*)	18.00	12.00
Birmingham (*Mexican*)	27.00	21.00
New Orleans (*Mexican*)	20.00	17.00

NOTE—Barrels or drums are optional in most cities. About 6 bbls. to the ton, and from 4 to 5 drums; 200 to 300 gal. to the ton. Drums used in New York.

PAVING STONE—Prices, f.o.b., in carloads or cargo lots:

New York (grade I)	granite, 5-in., 30 blocks per sq.yd.	$150.00 per M.
San Francisco	Basalt block 4x7x8	70.00 per M.
Chicago	about 5x8x5 dressed	3.60 per sq.yd.
	about 5x8x5 common	3.25 per sq.yd.
Boston	Granite, 5-in.	135.00 per M.
Atlanta	Granite	2.50 per sq.yd.
Detroit	Granite, 5-in.	3.00 per sq.yd.
Baltimore	Granite	2.85 per sq.yd.
Montreal	Granite	104.75 per M.
New Orleans	Granite, 4x8x4	2.75 per sq.yd.
Cincinnati	Granite	*110.00* per M.
St. Louis	Granite, 5 in.	125.00@127.00 per M.
Kansas City	Granite	2.40 per sq.yd.
Philadelphia	Granite	*3.90@4.25* per sq.yd.
Minneapolis	Sandstone	2.74 per sq.yd.

FLAGGING—Prices in fair-sized quantities, alongside dock:

New York	Bronx, 4 ft. wide	$0.24 per sq.ft.
	Manhattan, 4 ft. wide	.24 per sq.ft.
	Queens, 5 ft. wide	.26 per sq.ft.
	6x24-in. cross-walk	1.30 per lin.ft.

CURBING—*New York*: Bluestone, f.o.b. barge, New York, 5x16 in., rough, 90c. per lin.ft., cutting charges extra.
St Louis: Class "B" straight, delivered, 5x16 in., 85c. per lin.ft.; roundings, $1.16@$1.41 per lin.ft.
Birmingham: Limestone, 5x18-in., f.o.b., $1.05 per lin.ft.

WOOD BLOCK, PAVING—Prices f.o.b. in carloads:

	Size of Block	Treatment	Per Sq.Yd.
New York	3	16	$2.40
New York	3½	16	2.70
Boston	3½	18	2.45
Chicago	4	16	2.25
Chicago	3½	16	2.10
St. Louis	3½	16	2.30
St. Louis	4	16	2.55
Minneapolis	3½	16	2.50
Atlanta	3½	16	2.00
New Orleans	3	16	2.20
New Orleans	3½	16	2.30
New Orleans	4	16	2.40
Dallas	4	18	3.90
Montreal	4	16	4.50
Detroit	3	16	1.94
Cincinnati	3½	16	2.35
Kansas City	4	16	2.50

Construction Materials

SAND AND GRAVEL—Prices are per cu.yd. delivered. Weight of sand, 1½ tons per cu.yd.; gravel, 1½ tons per cu.yd. unless otherwise specified in pounds.

	Gravel 1½ In.	Gravel ¾ In.	Sand
New York	$2.80@$2.90	$2.80@$2.90	$2.00
Denver (*2,700*)	1.50	1.50	.75 at pit
Chicago	2.25	2.25	2.25
St. Louis, per ton	1.45	1.45	1.20@1.45
Seattle (*3,200*) (*2,850*)	1.00	1.00	1.00
Dallas	2.50	2.50	2.25
Minneapolis (*2,800*)	2.25 ton	2.25 ton	*1.60*
Cincinnati, per ton	1.90	1.60	1.60
San Francisco (*2,800*) (*bunkers*)	1.80	1.80	1.40
Boston, per ton	1.90	1.90	1.35
New Orleans	2.75	2.75	1.75
Los Angeles, per ton	*1.90*	*1.90*	*1.30*
Atlanta	.....	.....	2.02
Detroit (*2,600*)	3.00	3.00	2.50
Baltimore	1.40	1.60	.70 at pit
Montreal, per ton	1.90	1.50	1.20
Birmingham (*2,700*)	.....	.....	2.65
Philadelphia, ton	2.05@2.90	2.05@2.90	1.40@2.25
Kansas City, Mo. at plant	2.40	2.40	.66 at pit
Pittsburgh, per ton	1.80	1.80	2.00

Note: New York gravel weighs 2,800@3,000 lb. and sand, 2,700 lb.

CRUSHED STONE—Prices are per cu.yd. delivered. Weight 1½ tons per cu. yd., unless otherwise specified in pounds:

	1½ In.	¾ In.
New York (*Limestone*)	$2.90@3.15	$3.00@3.25
Chicago (*Limestone*)	2.25	2.25
St. Louis, per ton (*f.o.b.*)	1.73	1.73
Dallas	3.25	3.40
San Francisco (*Trap rock*) (*2,400*) (*bunkers*)	1.70	1.70
Boston, per ton	2.25	2.25
Minneapolis (*Limestone*) per ton	2.25	2.25
Kansas City (*Limestone*) (*2,450*) at plant	2.40	2.40
Denver (*Granite*) (*2,700*)	2.50	2.50
Seattle (*2,700*)	1.90	1.90
Atlanta	.....	.....
Cincinnati, per ton	2.25	2.25
Los Angeles, per ton	*1.90*	*1.90*
Detroit (*Limestone*) ton	2.50	2.50
Baltimore	2.50	2.55
Montreal, per ton	.....	2.10
Philadelphia (*Limestone*) per ton	2.30@3.15	2.30@3.15
Pittsburgh, per ton	3.25	3.25
Cleveland, per ton	3.00	3.00
Birmingham (*Limestone*)	2.50	2.50

CRUSHED SLAG—Price of crushed slag in carloads, per net ton, at plant:

	1½-In.	¾-In.	Roofing	Sand
Youngstown District	$1.30	$1.40	$2.00	$1.30
Buffalo District	1.25	1.35	2.25	1.25
Birmingham, Ala.	.....	1.25	2.05	.....
Cleveland, Ohio	1.20	1.20	.....	1.30
Eastern Pa. and Northern N. J.	1.25	1.25	2.00	1.25
Western Pennsylvania	1.25	1.25	2.00	1.25
Toledo, Ohio	1.25	1.25	....	1.25

LIME—Prices delivered to job:

	Hydrated, per Ton—Finishing	Hydrated, per Ton—Common	Lump, per Barrel—Finishing	Lump, per Barrel—Common
New York	$21.00@22.00	$14.00@15.00	$4.00@4.10*	$3.15@3.25*
Chicago	20.00	18.00	.....	1.50†
St. Louis	24.00	18.00	.....	15.00‡
Boston	19.00	13.00	3.85*	2.75*
Dallas	20.00	.....	.....	18.00‡
Cincinnati	16.80	13.20	.....	13.20‡
San Francisco	27.50	24.50	.....	1.70†
Minneapolis	25.50	21.00	.....	1.70†
Denver	*20.00*	.....	.....	2.75@3.00*
Detroit	19.20	14.80	2.20†	2.20†
Seattle, *paper sacks*	24.00	.....	.....	2.80*
Los Angeles	26.00	18.00	2.40†	18.00‡
Baltimore	24.25	13.00	2.55†	.....
Montreal	.....	21.00	.....	12.00‡
Atlanta	25.00	15.00	.....	1.25@1.65†
New Orleans	.....	.....	.....	2.00*
Philadelphia	*22.00*	15.00	.....	.....
Kansas City	.....	.....	.....	.....
Birmingham	22.50	16.00	2.40†	1.85†
Pittsburgh	22.00	18.00	.....	.....

*Per 280-lb. bbl. (net). †Per 180-lb. (net). ‡Per ton.

NATURAL CEMENT—Prices per bbl. delivered to contractors, without charge for bags:

Minneapolis (Rosendale)	.....
Kansas City (Ft. Scott) (f.o.b.)	$1.80
Cincinnati (Utica) (f.o.b.)	1.72
Boston (Rosendale)	.....
St. Louis (Carney)	2.10
Birmingham (Magnolia) pozzolan cement	2.60

PORTLAND CEMENT—Prices per bbl. delivered to contractors, in carloads, *without charge for bags*. Cash discount not deducted.

	Current	One Month Ago F.O.B.	One Year Ago F.O.B.
New York	$2.25@$2.35	$2.25@$2.35	$2.35@$2.50
Jersey City	2.13	2.13	2.28
Boston	2.25	2.05	2.25
Chicago (f. o. b.)	2.05	2.05	2.05
Pittsburgh (f. o. b.)	2.04	2.04	2.04
Cleveland (f. o. b.)	2.24	2.24	2.24
Detroit (f. o. b.)	1.90	1.90	2.15
Indianapolis, (f. o. b.)	2.19	2.19	2.19
Milwaukee (f. o. b.)	2.20	2.20	2.20
Duluth (f. o. b.)	2.04	2.04	2.04
Peoria (f. o. b.)	2.22	2.22	2.22
Cedar Rapids (f. o. b.)	2.24	2.24	2.24
Davenport (f. o. b.)	2.24	2.24	2.24
St. Louis	2.45	2.05	2.05
San Francisco	2.41	2.41	2.51
New Orleans	2.50	2.07	2.40
Minneapolis (f. o. b.)	2.22	2.22	2.22
Denver	2.85	2.85	2.85
Seattle	2.65	2.65	2.65
Dallas	2.40	2.05	2.05
Atlanta	2.30	2.15	2.35
Cincinnati (f. o. b.)	2.22	2.22	2.32
Los Angeles	2.60	2.50	2.50
Baltimore	2.54	2.50	2.50
Birmingham	2.60	2.40	2.40
Kansas City, Mo.	2.50	2.10	2.20
Montreal (f. o. b.)	1.41	1.41	1.41
Philadelphia	*2.21*	2.40	2.50
St. Paul (f. o. b.)	2.22	2.22	2.22
Toledo (f. o. b.)	2.20	2.20	2.20

Current mill-prices per barrel, in carloads, without bags, f.o.b., to contractors:

Buffington, Ind.	$1.80	Richard City, Tenn.	$1.85
Universal, Pa.	1.80	North Birmingham, Ala.	1.45
Steelton, Minn.	1.85	Leeds, Ala.	1.65
Fordwick, Va.	2.05	Hannibal, Mo.	1.90
Mitchell, Ind.	1.90	Lehigh Valley District	1.75
Iola, Kan.	1.85	Wyandotte, Mich.	1.65
Mason City, Ia.	1.80	Alpena, Mich.	1.60
La Salle, Ill.	1.90	Kingsport, Tenn.	2.05
Hudson, N. Y.	1.75	Clinchfield, Ga.	1.65

E. N.-R. Prices of Construction Materials

TRIANGLE MESH—Price per 100 sq.ft. in carloads at mills; from warehouses per 100 sq. ft. in lots of 10,000 sq.ft. or over.

PLAIN 4-INCH BY 4-INCH MESH

Style Number	Weight in Pounds per 100 sq.ft	Pittsburgh Mill	Chicago District Mill	Warehouse: New York*	St. Louis	Dallas	San Francisco
032	22	$0.99	$1.01	$1.39	$1.06	$1.13	$1.22
049	28	1.26	1.29	1.76	1.35	1.38	1.55
068	35	1.54	1.58	2.18	1.66	1.67	1.91
093	45	1.98	2.03	2.79	2.13	2.00	2.46
126	57	2.45	2.51	3.45	2.63	2.55	3.03
153	68	2.92	2.99	4.13	3.14	3.15	....
180	78	3.35	3.43	4.73	3.60	3.47	....
245	103	4.43	4.53	6.24	4.75	4.58	....
287	119	5.12	5.24	7.20	5.50	5.26	6.35
336	138	5.93	6.07	8.36	6.37	6.11	....
395	160	6.88	7.04	9.68	7.38	7.12	....

In rolls, 48-, 52-, and 56-in. wide and in 150-, 200- and 300-ft. lengths. Galvanized is about 15% higher.

*Delivered to job. Size of roll carried in New York warehouses, 48 in. wide x 150 ft. long, or 600 sq.ft.

EXPANDED METAL LATH—Per 100 sq.yd., painted, delivered to job in less-than-carload lots:

Weight in Pounds per Sq. Yd.	New York	Birmingham	Chicago	St. Louis	San Francisco	Dallas
2.2	$19.00	*$19.50*	$18.00	*$16.00*	*$15.50*	$21.50
2.5	*20.00*	*21.50*	19.00	*17.00*	*16.50*	24.00
3.0	*22.00*	24.50	21.00	*18.50*	*19.00*	....
3.4	*23.50*	27.50	22.50	*20.00*	*21.00*	30.50

BARS, CONCRETE REINFORCING—Pittsburgh and Birmingham prices are in carloads, per 100 lb., f.o.b. mill. In other cities listed, prices are per 100 lb., for bars delivered from warehouse stocks.

ROLLED FROM BILLETS

Inches	Pittsburgh	Birmingham	Warehouse: New York	Chicago	St. Louis	Dallas	San Francisco
½" and larger	$1.90	$2.00	$2.80@3.24	$2.30@2.75	$3.15	$3.75	*$2.50*
⅝	2.00	2.10	2.90@3.34	2.40@2.85	3.25	3.95	*2.60*
¾	2.10	2.20	3.00@3.44	2.50@2.95	3.35	3.95	*2.70*
⅞	2.30	2.40	3.20@3.64	2.70@3.15	3.55	4.10	*2.90*
1	2.90	3.00	3.80@4.24	3.30@3.75	4.15	4.75	*3.50*

For standard classification of extras for size and cutting of steel bars, see bar card of July 15, 1923.

BRICK—Contractors price, delivered, per M, is as follows:

	Common	Paving F.O.B.: 3x8¼x4-in.	3½x8¼x4-in.
New York	$16@19	$45.00	$51.00
Chicago	12.00	42.00	45.00
St. Louis, salmon	14.00	40.00 del.	42.50del.
Denver, salmon	8@12	.....	.....
Dallas	15.00	35.00	.....
San Francisco	13.00	.....	.....
Los Angeles	10.00	.....	.....
Boston	17.50	45.00 del.	*52.00*del.
Minneapolis	13.50	.....	.....
Kansas City	14.00	45.00	55.00
Seattle	14.00	.....	55.00
Cincinnati	18.00	40.00	45.00
Montreal	20.33	100.00*	.....
Detroit	15.50	35.50	38.50
Baltimore	18.00	40.00	45.00
Atlanta	12.00	40.00	.....
New Orleans	16.00	60.00	75.00
Birmingham	17.00	50.00 del.	60.00del.
Philadelphia	17.00	40.00	*46.00*
Pittsburgh	17.00	.....	.....
Cleveland	14@16	.....	.....

*Imported.

HOLLOW TILE—Price of hollow building tile per block delivered to contractors in lots of 2,000 pieces or over:

	4x12x12	6x12x12	8x12x12	10x12x12	12x12x12
Boston	*$0.0775*	.....	*$0.1375*	.....	*$0.2325*
Minneapolis	.0842	.....	.1476	.....	.2441
Cincinnati	.074	.....	.136	.....	.205
Kansas City	.076	.....	.138	.....	.214
Denver	.085	.....	.155	.....	.22
Seattle	.10	.....	.18	.....	.26
Los Angeles	.085	.....	.172	.....	.285
New Orleans	.09	.....	.165	.....	.245
Detroit	.092	.....	.174	.....	.244
Montreal	.12	.....	.22	.....	.315
Baltimore	.124	.....	.268	.....	.....
Atlanta	.0724	.....	.1358	.....	.....
Dallas	.985	.1205	.1785	.284	.....
Birmingham	.068	$0.09	.126	$0.158	.186
Pittsburgh	.06	.....	.115	.....	.17
Cleveland	.06	.....	.12	.....	.....
New York	.1004	.1506	.1883	.2313	.3084
Chicago	.076	.104	.142	.182	.202
Philadelphia	.11	.....	.22	.....	.34
St. Louis	.078	.105	.145	.175	.210
San Francisco	.108	.156	.255	.....	.....
Perth Amboy, N. J. (f.o.b.)	.....	.....	.....	.252	.312

STRUCTURAL MATERIAL—Pittsburgh and Birmingham prices are in carloads, per 100 lb., f.o.b. mill. At other cities listed, quotations apply on less-than-carload lots delivered from warehouse:

	Pittsburgh	Birmingham	Warehouse: New York	Dallas	St. Louis	Chicago	San Francisco
Beams, 3 to 15 in.	$1.90	$2.00	$3.34	$4.00	$3.25	$3.10	$3.25
Channels, 3 to 15 in.	1.90	2.00	3.34	4.00	3.25	3.10	3.25
Angles, 3 to 6 in., ¼ in. thick	1.90	2.00	3.34	4.00 4.00	3.25	3.10	3.25
Tees, 3 in. and l'rg'r.	1.90	2.00	3.34	4.00	3.25	3.10	3.25
Plates, ¼ in. thick and heavier	1.90	2.00	3.34	4.00 4.00	3.25	3.10	3.25

RIVETS—The following quotations are per 100 lb., full packages, delivered from warehouse:

ROUND-HEAD STRUCTURAL

	Pittsburgh Mill†	Warehouse: New York	Chicago	St. Louis	San Francisco	Dallas
½ in.	$2.90	$5.00	$3.60*	$3.75	$5.75	$4.75

CONE-HEAD BOILER

½ in.	$3.20@3.30	$5.00	$3.60	$3.90	$5.75	$5.00

*F.O.B.

NAILS—The following quotations are per 100 lb. keg from warehouse:

	Pittsburgh Mill	Birmingham	Chicago	San Francisco	Dallas	St. Louis	Montreal
Wire	$2.65	3.10	$3.10	$3.50	$4.00	$2.83½	$4.95
Cut	2.80	3.30	....	5.00	5.00	....	5.00

SHIP SPIKES—Current prices per 100 lb. delivered from warehouse:

In.	San Francisco: Galv.	San Francisco: Black	Seattle Black
½	$7.30	$5.55	$7.75
⅝	6.85	5.10	5.65
¾	6.70	4.95	5.50

Pittsburgh base in lots of 200 kegs or more, *$2.90@$3.00* per 100 lb.

PREPARED ROOFINGS—Slate-surfaced roofing in rolls weighing 85 to 90 lb. costs $1.93¾ per square to contractors in carloads f.o.b. New York.

Single shingles, slate finish, cost $5.62½ per square (sufficient to cover 100 sq.ft.) in carloads f.o.b. New York.

Strip shingles (4 in 1) f.o.b. New York, in carloads to contractors, are $4.27½ per square for the hexagonal shape, with Underwriters' label.

ROOFING MATERIALS—Prices f.o.b. New York, to contractors in carloads:

Tarred felt per 100 lb.	$2.94½
Asphalt coating, per gal.	31¼
Asphalt felt, per 100 lb.	3.09

WINDOW GLASS—United inches, 25, bracket size 6x8 to 10x15, discount from jobbers' list at New York warehouses:

Single Thickness		Double Thickness	
AA	83%	AA	83%
A	88%	A	88%
B	90%	B	90%

SHEETS—Quotations are per 100 lb. in various cities out of stock at warehouse; also the base quotations at mill:

Blue Annealed	Pittsburgh Large Mill Lots	St. Louis	Chicago	San Francisco	New York
No. 10	*$2.00@$2.10*	$3.60	$3.50	$3.85	$3.89
No. 12	*2.05@* 2.15	3.65	3.55	3.90	3.94
No. 14	*2.10@* 2.20	3.70	3.60	3.95	3.99
No. 16	*2.20@* 2.30	3.80	3.70	4.10	4.09
Black					
Nos. 18 to 20	*2.60@* 2.70	4.25	3.75	4.75	4.00
No. 22	*2.75@* 2.85	4.40	3.90	4.90	4.15
No. 24	*2.80@* 2.90	4.45	3.95	4.95	4.20
No. 26	*2.90@* 3.00	4.55	4.05	5.00	4.30
No. 28	*3.05@* 3.15	4.70	4.20	5.20	4.45
Galvanized					
No. 10	2.95@3.05	4.55	4.10	....	4.25
Nos. 12 to 14	3.05@3.15	4.65	4.20	4.90	4.35
No. 16	3.15@3.25	4.75	4.30	5.00	4.45
No. 18	3.30@3.40	4.90	4.45	5.15	4.60
No. 20	3.45@3.55	5.05	4.60	5.30	4.75
No. 22	3.50@3.60	5.10	4.65	5.35	4.80
No. 24	3.65@3.75	5.25	4.80	5.50	4.95
No. 26	3.90@4.00	5.50	5.05	5.75	5.20
No. 28	4.15@4.25	5.75	5.30	6.00	5.45

LINSEED OIL—These prices are for raw oil in barrels, delivered in 5-bbl. lots:

	New York	Chicago	Minneapolis
Per 7½-lb. gallon	$0.76½	$0.78	$0.87

E. N.-R. Prices of Construction Materials

WHITE AND RED LEAD—Per 100-lb. keg, base price, f.o.b. New York:

	Dry	In Oil
Red	$13.75	$15.25
White	13.75	13.75

Lumber

Prices per M. ft. b.m., Delivered in Carloads.

San Francisco—Prices of rough Douglas fir No. 1 common, in carloads delivered to contractors at site of job:

	10-16-18 and 20 Ft.	22 and 24 Ft.
3x3 and 4	$28.00	$29.00
3x6 and 8	28.00	29.00
3x10 and 12	28.00	29.00
3x14	31.00	33.00

Chicago—Prices per M. ft. b.m.:

	20 Ft. and Under No. 1 Long-Leaf Yellow Pine	Up to 32 Ft. No. 1 Douglas Fir
3x4 to 8x8	$37.50	$39.00
3x10 to 10x10	45.00	39.00
3x12 to 12x12	55.00	39.00
3x14 to 14x14	.....	39.00
3x16 to 16x16	.....	40.50

New York—Delivered prices per M. ft. b.m. to contractors:

	20 Ft. and Under Long-Leaf Yellow Pine	22-24 Ft. Long-Leaf Yellow Pine
3x4 to 8x8	$46.00@48.00	$47.00@49.00
3x10 to 10x10	53.00@55.00	54.00@56.00
3x12 to 12x12	60.00@62.00	61.00@63.00
3x14 to 14x14	68.00@70.00	69.00@71.00
3x16 to 16x16	80.00@82.00	81.00@83.00

Over 24 ft.—Add $1 for each additional 2 ft. in length up to 32 ft. and $1 for each additional foot from 32 to 36 ft. Short leaf pine costs $3 per M. ft. less.

Other Cities—Delivered to job:

	8x8-In. x 20 Ft. and Under, Rough				3x12 to 12x12-In. 20 Ft. and Under, Rough	
	Pine*	Fir†	Hem-lock	Spruce	Pine*	Fir†
Boston	$47.50	$47.00	48.00	$51.00	$57.00	$56.00
Seattle	.....	23.00	.....	.....	.....	23.00
New Orleans	40.00	56.00	.....	.....	61.00	61.00
Baltimore	35.00	49.25	53.00	50.00	74.00	49.25
Cincinnati	33.00	46.00	44.00	44.00	37.00	50.00
Montreal	50.00	55.00	.....	.....	49.00	46.00
Los Angeles (yard)	.....	32.00	.....	32.00	.....	32.00
Denver	.....	31.75	.....	.....	.....	32.75
Minneapolis (f.o.b.)	44.25	37.75	36.25	.....	48.25	38.25
Atlanta	31.00	.....	.....	.....	45.00	.....
Dallas	57.50	.....	.....	.....	57.50	.....
Kansas City, Mo.	40.75	38.75	.....	.....	53.75	38.75
Birmingham	35.00	.....	.....	.....	55.00	.....
Philadelphia	48.00	35.00	40.00	43.00	60.00	35.00
Detroit	42.00	38.85	.....	.....	56.00	38.85
St. Louis	41.00	.....	.....	.....	51.00	.....

	1x10 In. x 16 Ft. and Under, Common			2x10 In. x 16 Ft. T. & Gr.	
	Pine*	Fir†	Hem-lock	Pine*	Fir†
Boston	$43.00	$42.50	$44.00	$48.00	$47.50
Seattle	.....	22.00	.....	.....	23.50
New Orleans	32.00	.....	.....	40.00	.....
Baltimore	55.00	44.00	44.00	34.00	49.25
Cincinnati	27.00	32.00	30.00	28.00	45.00
Montreal	45.00	48.00	40.00	.....	.....
Los Angeles (yard)	.....	24.50	.....	.....	36.00
Denver	.....	32.25	31.25	.....	30.25
Minneapolis(f.o.b.)	39.75	35.25	34.75	33.75	33.25
Atlanta	40.00	.....	.....	40.00	.....
Dallas	.....	.....	.....	57.50	.....
Kansas City, Mo.	56.25	41.80	.....	38.00	29.25
Birmingham	36.00	.....	.....	36.00	.....
Philadelphia	32.00	35.00	37.00	50.00	35.00
Detroit	40.50	37.00	.....	30.50	35.50
St. Louis	41.00	.....	.....	29.50	.....

*Long-leaf yellow pine. †Douglas fir.

PILES—Prices per lineal foot, pine piles with bark on, f.o.b. New York:

Diameters	Points	Length	Barge	Rail
12 in. at butt	6 in.	30 to 50 ft.	$0.14½	$0.18½
12 in.—2 ft. from butt	6 in.	50 to 59 ft.	.19	.23½
12 in.—2 ft. from butt	6 in.	60 to 69 ft.	.21½	.25½
14 in.—2 ft. from butt	6 in.	50 to 69 ft.	.25½	.34
14 in.—2 ft. from butt	6 in.	70 to 79 ft.	.27½	.36½
14 in.—2 ft. from butt	5 in.	80 to 89 ft.	.35	.41

Miscellaneous

STEEL SHEETPILING—The base price f.o.b. Pittsburgh mill is $2.25 @ $2.35 per 100 lb.

CONCRETE BLOCKS—Standard 8x8x16-in., delivered to job, each:

Denver	$0.22	St. Louis	$0.20
Detroit	.16	Boston	18@.20
New Orleans	.....	Minneapolis	.14
Brooklyn and Queens	.16@.18	Philadelphia	18@.25
Pittsburgh	.18		

WIRE ROPE—Discounts from list price on regular grades of bright and galvanized, are as follows:

	Eastern Territory New York and East of Missouri River
Plow steel round strand rope	35%
Special steel round strand rope	30%
Cast steel round strand rope	20%
Round strand iron and iron tiller	5%
Galvanized steel rigging and guy rope	7½%
Galvanized iron rigging and guy rope (*add to* ∝)	12½%

California, Oregon, Nevada and Washington: Discount 5 points less than discount for Eastern territory.

Wyoming, New Mexico and Colorado: Discount 5 points less than discount for Eastern territory.

Arizona: Discount 10 points less than discount for Eastern territory.

Montana, Idaho and Utah: Discount 10 points less than discount for Eastern territory.

North Dakota, Nebraska, Kansas, Oklahoma and Texas: Discount 5 points less than discount for Eastern territory.

MANILA ROPE—For rope smaller than ¾-in. the price is ½ to 2c. extra; while for quantities amounting to less than 600 ft., there is an extra charge of 1c. The number of feet per pound for the various sizes is as follows: ⅜-in., 8-ft.; ½-in., 6-ft.; ⅝-in., 4½-ft.; 1-in., 3½-ft.; 1¼-in., 2-ft. 10-in.; 1½-in., 2-ft. 4-in. Following are prices per pound for ¾-in. and larger delivered in 1200-ft. coils:

Boston	$0.255	New Orleans	$.23½
New York	.26	Los Angeles	.25
Chicago	.21	Seattle	.23
Minneapolis	.23	St. Louis	.21½
San Francisco	.23½	Montreal	.24½
Atlanta	.22	Detroit	.24½
Denver	.24	Baltimore	.25
Cincinnati	.21	Kansas City	.29½
Dallas	.21	Birmingham	.35@.40
Philadelphia	.25		

EXPLOSIVES—Prices per pound for dynamite delivered in small lots:

	Gelatin 40%	Gelatin 60%
New York (Special gelatin in case lots.)	$0.265	$0.2875
Boston	.25	.275
Kansas City	.2025	.2225
Seattle	.165	.19
Chicago (Quantities above 500 lb., but less than a ton.)	.195	.2175
Minneapolis	.2017	.2223
St. Louis	.22	.24½
Denver (f.o.b.)	.1975	.22
Dallas	.2325	.2525
Los Angeles (f.o.b. San Fernando Arsenal)	.1875	.2225
Atlanta	.245	.255
Baltimore	.22	.23
Cincinnati	.22	.245
Montreal	.195	.22
Birmingham (f.o.b.)	.155	.185
New Orleans	.235	.26
San Francisco	.1625	.1925
Philadelphia	.215	.24

CHEMICALS—Water and sewage treatment chemicals, round lots in the New York market:

Sulphate of aluminum, in bags, per 100 lb.	$2.00@$2.10
Sulphate of copper, in bbl., per 100 lb.	5.05 @ 5.10
Soda ash, 58%, in bags, per 100 lb.	1.32@ 1.35
Chlorine, liquid, cylinders, per lb.	.05½@ .08
Hypochlorite of lime (bleaching powder) in drums, per 100 lb.	2.00@2.10*

* F.o.b. works.

FREIGHT RATES—On finished steel products in the Pittsburgh district, including plates, structural shapes, merchant-steel bars, pipe fittings, plain and galvanized wire nails, rivets, spikes, bolts, flat sheets (except planished), chains, etc., the following freight rates are effective in cents per 100 lb., in carload lots of 36,000 lb. or 18 tons:

Atlanta	$0.58	Detroit	$0.29
Baltimore	.31	Kansas City	.735
Birmingham	.58	New Orleans	.67
Boston	.365	New York	.34
Buffalo	.265	Pacific Coast (all rail)	1.15*
Chicago	.34	Philadelphia	.32
Cincinnati	.29	St. Louis	.43
Cleveland	.19	St. Paul	.60
Denver	1.15*		

* Minimum carload, 50,000 lb. for structural steel only; 80,000 lb., for other iron or steel products.